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Estimating the ROI on an ERP for Naval aviation operations using market comparables

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

ESTIMATING THE ROI ON AN ERP FOR NAVAL AVIATION OPERATIONS USING MARKET COMPARABLES

by

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September 2006

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U.S. Navy aviation squadrons conduct a variety of flight operations in peace and wartime environments. At the heart of these operations is the flight scheduling that occurs to command and control the squadron's assets to ensure the actors and processes carry out the squadron's operations seamlessly and meet the squadron's mission requirements. This research and case study demonstrates how the Knowledge Value Added Methodology (KVA) and Business Process Reengineering (BPR) can be applied to these processes to analyze the performance and effectiveness of a Navy squadron's operations and maintenance departments. By analyzing the outputs of the sub processes involved at the squadron level in common units of change, a price per unit of output can be generated to allocate both cost and revenue at the sub process level. With this level of financial detail, a return on investment (ROI) analysis can be conducted for each process and the changes that occur to the processes when reengineering. A determination can then be made as to what level of reengineering if any should occur to the system to maximize ROI and what types of reengineering such as reducing costs, increasing value or implementing IT resources into the processes.

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U.S. Navy aviation squadrons conduct a variety of flight operations in peace and wartime environments. At the heart of these operations is the flight scheduling that occurs to command and control the squadron's assets to ensure the actors and processes carry out the squadron's operations seamlessly and meet the squadron's mission requirements. This research and case study demonstrates how the Knowledge Value Added Methodology (KVA) and Business Process Reengineering (BPR) can be applied to these processes to analyze the performance and effectiveness of a Navy squadron's operations and maintenance departments. By analyzing the outputs of the sub processes involved at the squadron level in common units of change, a price per unit of output can be generated to allocate both cost and revenue at the sub process level. With this level of financial detail, a return on investment (ROI) analysis can be conducted for each process and the changes that occur to the processes when reengineering. A determination can then be made as to what level of reengineering if any should occur to the system to maximize ROI and what types of reengineering such as reducing costs, increasing value or implementing IT resources into the processes.

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EXECUTIVE SUMMARY

The research team utilized the Knowledge Value Added Methodology (KVA) and Business Process Reengineering (BPR) to create a current "As Is" view, incrementally improved "To Be" view and redesigned "Radical" view of VFA-14 Strike Fighter Squadron's operations and maintenance department. The "As Is" view is the current depiction of the processes that occur on a daily basis to generate the squadron's flight schedule. These processes are highly manual in nature with limited use of Information Technology to aid squadron personnel in their completion. An incrementally improved "To Be" version of the same departments and their processes were created to demonstrate how reducing redundant processes and implementing IT resources would create an incrementally improved version of the "As Is" process.

A "Radical" depiction of the "As Is" and "To Be" views were then created to show what these processes would look like once resigned by implementing large amounts of IT to assist in completing the sub processes and streamlining all the processes to make them more efficient. The input for the radical views is obtained from the Israeli Air Force who utilizes an ERP and DSS program called OV-OMS 3.0 to run the command and control for their aviation squadrons. The "Radical" view of the Navy squadron's operations and maintenance departments is the anticipated improvements that would be gained if the processes that occur were resigned efficiently and the use of a program such as OV-OMS 3.0 were used to assist the Operation department's daily generation of the flight schedule and the maintenance department's support of the flight schedule.

The KVA methodology measures the common units of output and the changes to the output that occur to these processes when redesigning. It assumes that knowledge is valuable to the organization as measured by the amount of learning time, which is a surrogate for complexity, that must occur in an individual or system before a process can be completed. KVA theory with market comparables enabled the research team to identify the processes with the "As Is", incrementally improve them into the "To Be", and then redesign further into the "Radical" while measuring the changes that occurred in common units. Dollars are used as the common units to display the results in the language of financial analysis and determine the ROI of implementing IT resources in the form of an ERP into the manual “As Is” system.

The total return on knowledge percentages increases from the “As-Is”, “To-Be” and “Radical” models. The “As-Is” model returns a total ROK of 3427%. After incrementally improving the “As-Is” model with logical changes, the “To-Be” model returns a ROK of 4056%. This increase of 629% represents the result of applying minimal BPR techniques to reduce redundant processes and implementing small increases of information technology into largely manual processes. The “Radical” model returns an ROK of 6320% which is an increase of 2264% from the “To-Be” model. This model represents a larger redesign of processes with large increases of information technology to facilitate executing the processes. The input for the “Radical” models in both the operations and maintenance processes was attained from current practices in the Israeli Air Force who utilize an ERP program for similar processes. The Israeli Air Forces “As-Is” models and processes were the vision for the US Navy’s “Radical” models represented in this case study.

The cost of the processes or denominator in the ROI equation decreases from \$129.07 in the As Is models to \$69.98 in the radical models. The total allocated knowledge increases from 1585.25 knowledge units in the As Is models to 3201.24 knowledge units in the radical models. The research team concludes that implementing IT resources such as an ERP into Navy aviation operations and maintenance processes would provide positive results. This type of BPR should be examined and pursued if the opportunities present themselves and the resources and will exist to drive the change.

By assuming the “Radical” models were implemented in a US Navy squadron similar to the one examined in the case study, the following results could be expected. For the operations and maintenance departments to execute all of the processes on a daily basis to generate an approved flight schedule ready for execution would take approximately 7.2 hours of effort by the various actors occurring either in tandem or sequentially. The theoretical revenue generated per hour by these processes is \$4,423.08. This would generate approximately \$31,846 of revenue per day in the generation of a daily flight schedule. Assuming a squadron produces this flight schedule five times a week and 50 weeks out of the year, annual revenue of approximately $7,961,500 could be expected. The 12 squadron estimate revenue would be approximately $95,538,000.

The personnel costs to execute the processes in the “Radical” models for the operations and maintenance department are $69.98 per hour. By executing the processes in the same 7.2 hours and following the same number of occurrences per year to generate the flight schedule, the personnel costs per year to generate an approved flight schedule are $125,962.50. This would yield net revenue of $7,835,537.50 per year to generate a daily flight schedule using the processes in the “Radical” models. The personnel costs over 12 squadrons would be approximately $1,511,550.

The information technology costs for the system have not been addressed thus far. The following data has been obtained from Mr. Gamliel “Jicko” Shitrit, Director of Engineering at Xvionics Corporation. The costs to implement the system in one Navy Squadron such as the squadron used in the case study, VFA-14 would include implementation, licensing, maintenance, integration and customization. The total cost in year for a one squadron implementation would be approximately $585,000. This is a conservative estimate based on the number of systems the XV-OMS program would have to integrate with. The integration costs are approximately $50,000 per system XV-OMS would have to operate with. The $585,000 reflects only one integration cost of $50,000. This is a conservative estimate of the potential systems XV-OMS would have to integrate with as the current US Navy “As-Is” model reflects limited essential IT systems in use at the squadron level to conduct flight planning and maintenance activities. The costs to implement XV-OMS over 12 squadrons would be approximately $5,668,000 assuming each squadron integrated XV-OMS with one system. This reflects roughly a 10% discount in costs over a single squadron implementation.

The potential ROI from implementing XV-OMS ERP into a Navy squadron would be the annual estimated revenue of $7,961,000 less the personnel costs of $125,962.50 less the year one implementation cost of $585,000 divided by the personnel costs and implementation costs equals an ROI of approximately 1019.8% for one Navy squadron. The ROI for a 12 squadron implementation using the same formula would be approximately 1230.7%. These ROI calculations are based on conservative estimates of revenue and cost data and neither captures all of the potential costs, nor do they factor in the depreciation of the year one implementation costs over the lifecycle of the system. With over a 1000% ROI on the implementation of the XV-OMS system, these estimates are orders of magnitude above the breakeven point and make the acquisition and implementation of this system a real option for the U.S. Navy.

I. INTRODUCTION

A. PURPOSE STATEMENT

The Department of Defense (DoD) is constantly tasked with doing more with less. The volatile nature of the organization and the missions it carries out require great flexibility on the part of DoD managers and its member's ability to adapt to rapid change. There will never be enough resources to support all the systems and programs the DoD feels it needs in order to carry out the multitude of missions and maintain the necessary capabilities in support of the National Security Strategy of the United States of America.

The Knowledge Value Added (KVA) methodology authored by Professors Housel and Bell is a tool for decision makers and resource managers to evaluate the value of programs and processes to determine what program and processes have more or less value to the organization.[1] The KVA methodology can provide this measurement using revenue obtained from the market comparables approach to calculate the Return on Knowledge (ROK) ratio on an organization's entire process under evaluation or individual sub processes. This information can assist decision makers in determining where the resources of the organization are best utilized and on which processes will give the organization the highest ROK. The methodology and analysis does not deliver a perfect product from which decision makers can rely solely upon to make resource decisions or process improvement changes, however, it gives them a more logical and objective measure than other rationale for allocating limited resources. Traditionally these decisions could be biased or influenced by political motivations or subjective assessments about the value of a DoD organization or process.

The methodology will be applied to a Navy F/A-18 Super Hornet squadron based out of NAS Lemoore Ca. VFA-14 produces a daily flight schedule every day in which the squadron conducts flight operations. The KVA methodology, with market comparables approach, will be applied to the operation and maintenance departments' process of producing an approved daily flight schedule once all the various inputs are

[1] T. Housel and A.H. Bell. Measuring and Managing Knowledge, McGraw-Hill Irwin, 2001, p. 91.

received and de-conflicted. The KVA methodology will show the break down of this process into the various sub processes and the role of the various actors involved in the process.

B. BACKGROUND

The U.S. Navy F/A-18 aircraft squadrons operate around the world 24 hours a day, 7 days a week in a wide variety of operational environments, conducting a myriad of different types of operations that range from fleet replacement training to tactical strike missions. Today's modern operational Navy F/A-18 squadron would not be nearly as successful as it is, if it were not for the ability of each squadron to effectively plan and schedule flight missions, as well as the aircraft maintenance required in order to support its various missions.

While not deployed, Navy squadrons are attached to their respective Naval Air Stations around the world, with their primary responsibility being that of training and preparing for each of the squadrons upcoming deployment. This period of time is characterized by a rather lengthy training cycle, most commonly referred to as “workups”.

Workups, at a minimum, consist of a formal flight training syllabus that ranges in complexity from basic orientation flights for newly accessed pilots, to more difficult tasks such as multi-aircraft combined arms engagement training, all of which occur prior to the squadron's deployment.

Like many of the different types of organizations within the Navy, the sufficient availability of time and funding act many times as primarily two of the largest constraining factors. Each of the squadron’s largest two departments, Operations and Maintenance, must balance those constraining factors with finite resources such as available aircraft, pilots, maintenance man-power, available flight-hours, fuel, replacement parts as well as a multitude of other factors.

The ultimate goal of this effort is to effectively and properly train each of the squadrons pilots in order to assure that they will be fully prepared for the missions they will conduct while on routine deployment, or during a time of war.

In day-to-day operations, the squadron Operations Department, commonly referred to as OPS, works from a set of long-term requirements that include such a thing as a training syllabus. This training syllabus is a series of requirements that all pilots must complete prior to a deployment with the possibility in mind that they may have to execute the training during a live hostile environment. The OPS department, with guidance from the squadron training officer, is responsible for the creation of the daily flight scheduling process to schedule the flights required to meet the objectives of the squadron’s training syllabus.

The current state of daily operations is largely a manual process that consists of very little use of IT and a heavy reliance on the use of white boards. In many cases, the use of MS Excel spreadsheets is about as automated as the process ever becomes. The creation of the daily flight schedule involves the input of several key squadron personnel such as the Operations Officer (OPSO), Assistant Operations Officer (AOPSO), Schedules Officer (Scheds-O), Training Officer, NATOPS Officer, and the Commanding Officer (CO).

The result of this collaborative effort produces inputs that generate a preliminary (rough) daily flight schedule that will eventually be de-conflicted and reviewed by the necessary parties before it is submitted for ultimate approval and signature by the CO. Once the daily flight schedule has been approved, it becomes the basis for the next day's flight events, as well as other non-flying events.

The daily flight schedule is essentially the squadron's daily operational center of gravity around which all other events revolve. This is especially true for the Maintenance Department, whose primary responsibility is providing for the successful execution (e.g. the launching, recovery and fueling of aircraft) of the daily flight schedule, in addition to all other aircraft maintenance-related responsibilities.

The process of creating a daily flight schedule occurs each day the squadron is flying. Normally flights will only be scheduled for Monday through Friday while at their home base of Naval Air Station (NAS) Lemoore California, but occasionally a commitment will arise that requires a weekend flight schedule to be created as well.

The squadron that we based our research efforts on is Strike Fighter Squadron Fourteen (VFA-14), based out of NAS Lemoore California whom recently transitioned from the Grumman F-14 Tomcat to the Navy's newest addition, the Boeing F/A-18E “Super Hornet”.

VFA-14, like all Navy squadrons, utilizes the Schedules Officer to receive and incorporate all inputs from the various actors; such as the Training Officer and NATOPS Officer as well as the inputs from individual pilots who may be called upon to fly on a particular day in support of the flight schedule. Individual pilots may also provide input in the form of personal conflicts, or requests, commonly known as “snivels”. These snivels may include requests such as doctor’s appointments or other types of limitations to their availability to fly on a particular day or at a certain time.

The VFA-14 Schedules Officer uses primarily white boards, with some supplementary Information Technology (IT) resources such a Microsoft Word, Excel, and a new scheduling program called SHARP in order to help consolidate the daily inputs and to summarily generate the rough schedule for review and eventual approval by the key squadron personnel.

II. KNOWLEDGE VALUE ADDED (KVA)

A. THE KVA SOLUTION

1. Knowledge Value-Added (KVA) Theory

The Knowledge-Value-Added (KVA) methodology authored by Dr. Thomas Housel (Naval Postgraduate School) and Dr. Valery Kanevsky (Agilent Labs) initiated fifteen years ago is based on the principle that organizations, their people, processes and information systems have knowledge which equates to value to the organization. KVA helps identify the location of this knowledge in the organization and quantify it into value with a Return on Knowledge (ROK) ratio.[2] KVA is based on entropy and complexity theory and was developed to assist with business process reengineering efforts looking to measure the value of organizational processes versus the costs to generate the value. Entropy is defined in the American Heritage Dictionary as "a measure of the degree of disorder or change in a closed system." It can act as a surrogate for the amount of change that occurs to a business process from its input to the resulting output.[3]

By conducting a KVA analysis, managers and decision makers can determine which processes, people or assets are more valuable to the organization and where the resources of the organization are best directed to maximize their value and profitability.[4] They can examine how changes to the processes will affect the outputs and ascertain whether those changes to the output result in improved and more profitable processes for the organization. A common unit of knowledge is used to observe and measure the performance of an organization's processes to determine the ROK ratios. By using the market comparables approach, the ROK ratios can then be monetized into a common unit of output in dollars for financial analysis.

2. KVA Assumptions

The KVA methodology must identify and address the inherent assumptions in the methodology to ensure a basic level of understanding and reduce any uncertainty. KVA

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[2] Housel and Bell, p. 91.

[3] T. Housel, O. El Sawy, J. Zhong, and W. Rodgers, "Models for Measuring the Return on Information Technology: A Proof of Concept Demonstration." 22nd International Conference on Information Systems. December 2001. p. 13.

[4] Housel and Bell, p. 91.

examines the changes to the organizational processes or entropy and assess the value gained from these changes. The input for the change is the knowledge required to make the change. KVA measures the inputs, the changes and the value gained from these changes. Figure 1 illustrates the basic concept behind KVA theory.

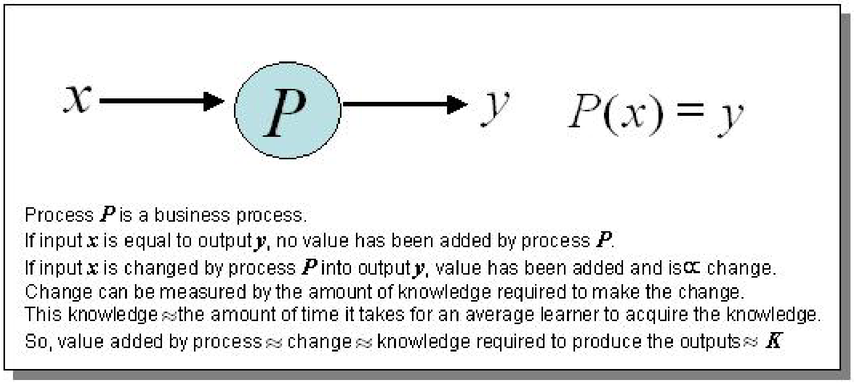

Figure 1. The Housel-Kanevsky Value-Added Cycle.[5]

KVA theory makes the assumption that all process outputs can be described in equivalent units such as the time required to learn how to produce an output. This provides the following advantages listed below:[6]

1. All Processes can be compared in terms of their relative productivity
2. Revenue can be allocated to a common unit of output
3. Value added by IT in terms of its outputs can be measured in common units
4. The cost to produce units of output can be measured in common units
5. Organizational productivity has a common unit of measure

The description and measurement of all an organization's process outputs into a common unit of output enables analysts to assign revenue and cost to the units of output. This enables traditional accounting measures and financial analysis to be applied to the organization at the sub-organizational level. Without a KVA analysis, traditional financial analysis could only be performed at the corporate aggregate level and still maintain a reasonable level of confidence in the accuracy of the results.

[5] Housel and Bell, p. 94.

[6] Housel and Bell, p. 11.

An additional assumption is the concept of Learning Time. Learning time is a surrogate for the procedural knowledge required to conduct a process and produce the process outputs. It is also a surrogate for complexity where more complex processes should require more learning time before it can be successfully performed. The procedural knowledge can be embedded in the people who conduct the process, an IT system or manuals and references called upon to train personnel or operate systems. The units of learning time are represented by the variable K and represent common units of output. By executing a process once, a single unit of output is produced as one unit of K. The return on K or knowledge can then be calculated and represented as a ROK ratio. The market comparable approach can then apply a revenue stream to the process to determine the ROI for the process.

The three approaches that can be used in KVA theory to determine the common unit of knowledge are learning time, process description, or binary query method.[7] These three methods are illustrated in Table 1.

For the purposes of this thesis and the analysis of VFA-14 flight scheduling and maintenance processes, learning time will be the method utilized and applied to the case study that follows. Learning time was chosen to conduct the knowledge audit over the other three methods for its straightforward and understandable steps. The remaining two methods, process description and binary query method will be discussed later in this chapter. Learning time is also the most relevant method to apply to a Navy aviation squadron’s processes and the easiest to explain to the numerous squadron personnel that were interviewed while collecting data. Learning time is a surrogate for complexity meaning the longer it takes to learn how to do a process the more complex it should be.

[7] Housel and Bell, pp. 94-95.

Learning Time Approach	**Process Description Approach**	**Binary Query Method**
Identify compound process and its component processes.	Identify compound process and its component processes.	Identify compound process and its component processes.
Establish common units to measure learning time.	Describe the products in terms of the instructions required to reproduce them and select unit of process description	Create a set of binary YES/NO question such that all possible outputs are represented as a sequence of YES/NO answers.
Calculate learning time to execute each component process.	Calculate number of process description words, pages in manual, lines of computer code pertaining to each process.	Calculate length of sequence of YES/NO answers for each component processes.
Designate sampling time period long enough to capture a representative sample of the compound processes' final product/service output.	Designate sampling time period long enough to capture a representative sample of the compound processes' final product/service output.	Designate sampling time period long enough to capture a representative sample of the compound processes' final product/service output.
Multiply the learning time for each component process by the number of times the component executes during sample period.	Multiply the number of process words used to describe each component process by the number of times the component executes during sample period.	Multiply the length of the YES/NO string for each component process by the number of times this component executes during sample period.
Allocate revenue to component processes in proportion to the quantities generated by previous step.	Allocate revenue to component processes in proportion to the quantities generated by previous step.	Allocate revenue to component processes in proportion to the quantities generated by previous step.
Calculate the cost to execute each component process, calculate return on investment per process by dividing revenue allocated to component process by cost of component	Calculate the cost to execute each component process, calculate return on investment per process by dividing revenue allocated to component process by cost of component	Calculate the cost to execute each component process, calculate return on investment per process by dividing revenue allocated to component process by cost of component

Table 1. The Three Approaches to KVA

The person doing the process must call upon more knowledge or the learning they went through to complete the process or action successfully. KVA theory calculates the ROK ratio for a process and its sub processes. The ROK ratio is based on the benefits of the process divided by the costs to complete the process. The theory works best for profit companies that generate revenue and have traditional costs associated with their processes. The revenue and the costs can be allocated to the processes being examined to determine which ones are the most profitable. The DoD does not generate revenue, but has costs associated with all of its processes. In order to apply the theory to DoD processes the market comparables approach is utilized to generate a revenue stream that can be allocated to DoD's non revenue generating processes.

B. KVA METHODOLOGY

1. The Value Problem

Public and private sector organizations need a valuation method to determine the value and knowledge resident in their personnel and IT systems. Subjective evaluations do little to accurately measure the organization in order to justify the investment of IT resources for the organization. The term value must be defined as value can be interpreted in different ways depending on the context it is applies to. Dr Myron L. Cramer defines the term value in terms of dollars as how much is earned or saved. The metric of dollar-value is primarily used in assessing contributions in a commercial or business context.[8]

The DoD represents a unique challenge when attempting to value its organizations processes, personnel, systems and missions. As a not for profit organization that does not generate a revenue stream or income, it is difficult to determine the revenue or benefits side of the ROI equation. Valuing the mission effectiveness of combat operations or peace time deterrence is a unique and difficult challenge as it is impossible to predict what would have happened if DoD operations had not been conducted. This challenge usually relegates this debate to determining the costs that were avoided or would have been avoided if the DoD had not been present to prevent a conflict or contain a crisis. ROI is typically used inaccurately to measure this cost avoidance and the

[8] Myron Cramer, "Measuring the Value of Information." Atlanta, GA: Georgia Tech Research Institute. 20 July 2005, http://iw.gtri.gatech.edu, last accessed 31 August 2006, p. 2.

subjective value of the DoD for generating it. When used accurately ROI must measure the benefits or revenue generated in the numerator of the ROI equation.

The DoD is presented with an additional challenge to quantify the measure of the value of its processes and personnel, regardless of the methodology used, into some common unit of output. Value is traditionally measured and reported in dollars as a price per unit of output in for-profit organizations. As DoD is a not-for-profit organization, the measured value cannot be represented in a price per unit of output in dollars. An alternate approach from a traditional for-profit organization must be used to conduct a financial analysis of the DoD.

2. The Method

The Knowledge-Value-Added (KVA) methodology is based on the principle that organizations, their people and their processes have knowledge which equates to value to the organization. KVA helps identify the location of this knowledge in the organization and quantify it into value with a Return on Knowledge (ROK) ratio.[9] By doing this, managers and decision makers can determine which processes, people, or assets are more valuable to the organization and where the resources of the organization are best directed to maximize their value and profitability.[10] A common unit of knowledge is used to observe and measure the performance of an organization's processes to determine the ROK ratios.

[9] Housel and Bell, pp. 91-95.

[10] Housel and Bell, pp. 91-95.

C. KVA IN 10 EASY STEPS

1. Define the AS-IS Process and ensure that the sponsor concurs with the process as described.
2. Conduct the Knowledge Audit
   a. Determine Actual Learning Time (ALT)
   b. Determine Nominal Learning Time (NLT) 100 units of time
   c. Determine Ordinal Ranking (Optional) Rank 1-X
3. Determine number of organizations involved
4. Determine number of people/organization involved
5. Determine number of “times fired” per time period
6. Determine “working time” for each “time fired”
7. Determine cost per time unit for working time (if applicable)
8. Determine NUMERATOR:
   a. ALT or NLT times
   b. Number of organizations involved times
   c. Number of people involved times
   d. Times fired
9. Determine Denominator
   a. Time to complete times
   b. Number of people involved times
   c. Number of organizations involved times
   d. Times fired times
   e. Cost per unit of time (if applicable)
10. Determine ROK
    a. Numerator/Denominator

D. MARKET COMPARABLES

Market comparables are widely used in real estate where the sales price of one home may help determine the sales price of another home in the same neighborhood if the two houses are comparable.[11] Some of the DOD’s processes and functions are more comparable to civilian organizations that generate revenue than others. A B-2 bomber dropping a JDAM bomb on a target in support of the war on terror is not likely to have a market comparable as there are no for-profit organizations that generate revenue from conducting such operations. On the other hand, the Air Mobility Command (AMC) has a close market comparable with companies like UPS and FEDEX. Both AMC and UPS deliver cargo via aircraft from one location to another and in some cases use very similar aircraft over the same routes. Both organizations have their individual costs which can be allocated to their processes. AMC does not generate revenue in the traditional sense like

[11] P. Candreva, example mentioned in MN3154 class, taught at NPS, Monterey, CA, Winter 2006.

UPS or FEDEX, but if the AMC process that we are applying the KVA theory to has enough common factors as an UPS process such as similar aircraft, cargo, and the route flown, the revenue generated from the UPS or FEDEX process could be allocated to the AMC process assuming AMC would generate a similar level of revenue if it were a revenue generating activity. Allocating this revenue helps generate the numerator or benefits side of the ROK ratio in a common unit of measure, in this case dollars.

For the analysis of VFA-14 flight scheduling and maintenance processes, the revenue estimate for the market comparable was obtained from a company called Executive Jet Management, a Net Jets company. Executive Jet Management provides charter air service management for small and large cabin charter corporate jets using fractional jet ownership of their aircraft by their clients. They estimate that a small cabin executive jet under their management will generate $2300 of revenue for every flight hour in operation.[12] The 12 F/A-18 jets in the VFA-14 squadron fly approximately 4000 hours per year total when non-deployed and conduct peace time training at their homeport in NAS Lemoore Ca.[13] The 4000 hours times the $2300/hr revenue market comparable yields a $9,200,000 revenue estimate contained in the Numerator column and gets allocated to each of the sub processes based on their value to the overall process. This is not a perfect market comparable, but is a reasonable revenue estimate for a Navy F/A-18 squadron assuming it could generate revenue.

The market comparables approach does not have to generate an exact comparable between two organizations for a KVA analysis to be conducted between the organizations. The $9,200,000 total annual revenue estimate was also compared to Executive Jet Managements estimate that 12 of their small cabin corporate jets achieved revenue of $12M for one year in 2004.[14] The $9.2M appears to be a reasonable estimate for 12 Navy F/A-18 jets given that it is unlikely that a military jet could achieve the same level of revenue as corporate charter jets if the two types of aircraft could compete against each other in a for-profit environment. This conclusion was also arrived at since

[12] Net-Jets an executive jet management company, Fractional Aircraft Ownership, http://www.executivejetmanagement.com/aircraft_mgmt/revenue.asp, last accessed 30 August 2006. state

[13] This estimate was obtained from personal interview conducted with VFA-14 personnel, June 2005.

[14] Net-Jets an executive jet management company, Fractional Aircraft Ownership, http://www.executivejetmanagement.com/aircraft_mgmt/revenue.asp. last accessed 30 August 2006.

an F/A-18 is more costly to schedule its missions and maintenance given the increased complexity of its missions and systems over a small cabin corporate jet which flies routine routes.

However, there are plenty of similarities between the two organizations which operate jet aircraft. They both must complete the maintenance on aircraft in order to meet a schedule. Both organizations must complete a scheduling process that allows the allocation of finite resources such as personnel and equipment. The organizations also divide the duties of operating an aviation unit into various departments that own the different processes that comprise the company or squadron. Examples would be the existence of a maintenance department, operations/scheduling department, maintenance and operational administrative departments, and management or leadership personnel that oversee all of the processes on a daily basis. The fixed revenue figure of $9.2M would be allocated across all of these functions inside of both organizations.

E. ANALYSIS OF VFA-14 SCHEDULING PROCESS

The spreadsheet, denoted by Figure 2, is an example of the KVA methodology with market comparables applied to VFA-14 current flight scheduling process. The input values for the spreadsheet such as learning time (LT), time to complete, % IT, the number of persons involved in the process and who they are were obtained during a research trip to VFA-14. Face to face interviews were conducted with the key players of the listed sub processes. Direct observations of the entire process in action took place to provide further understanding of the "As-Is" process and ascertain the timeframe for completion. The positional titles are listed in the far left hand column.

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	% IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	# of persons	Annual Salary ($)	TLT x # fired x # of	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Ops Officer	Study long range schedule	8	6		16	16	10	17.78	2	1	1	$100,000	17.78	0.30%	$27,731	$200,000	14%
	Conduct Firing Ranges scheduling	11	10		40	40	20	50.00	0.5	3	1	$100,000	150.00	2.54%	$233,983	$150,000	156%
	Critique/approve daily schedule	7	5		8	8	25	10.67	0.25	5	1	$100,000	53.33	0.90%	$83,194	$125,000	67%
Asst Ops Office	Build 2 week schedule	10	8		40	40	50	80.00	2	0.5	1	$80,000	40.00	0.68%	$62,396	$80,000	78%
	Build 1 week schedule	6	4		8	8	50	16.00	1	1	1	$80,000	16.00	0.27%	$24,958	$80,000	31%
	Critique/approve daily schedule	2	1		2	2	35	3.08	0.25	5	1	$80,000	15.38	0.26%	$23,998	$100,000	24%
Sched. Officer	Deconflict Daily schedule	15	18		160	160	80	800.00	1	5	1	$50,000	4000.00	67.82%	$6,239,559	$250,000	2496%
	Create daily schedule	14	12		80	80	50	160.00	2	5	1	$50,000	800.00	13.56%	$1,247,912	$500,000	250%
	Route daily schedule for approval	1	0.5		0.5	0.5		0.50	0.5	5	1	$50,000	2.50	0.04%	$3,900	$125,000	3%
NATOPS	Update / Input pilot qualifications	3	1.5	20	4	24	30	34.29	0.5	5	1	$100,000	171.43	2.91%	$267,410	$250,000	107%
	Check schedule for NATOPS violations	4	2	20	4	24	50	48.00	0.5	5	1	$100,000	240.00	4.07%	$374,374	$250,000	150%
Training Officer	Plan proficiency training syllabus	13	11	40	40	80	30	114.29	2	1	1	$100,000	114.29	1.94%	$178,273	$200,000	89%
	Integrate training syllabus in L.R. schedu	12	10.5		40	40	30	57.14	1	1	1	$100,000	57.14	0.97%	$89,137	$100,000	89%
	Daily review/update training syllabus	5	3.5		4	4		4.00	0.5	5	1	$100,000	20.00	0.34%	$31,198	$250,000	12%
CO	Critique/approve daily schedule	9	7	24	16	40		40.00	0.25	5	1	$125,000	200.00	3.39%	$311,978	$156,250	200%
	TOTAL		100										5897.85	100.00%	$9,200,000	$2,816,250	327%
	Correlation factor (NT-ALT)	0.9002															

Figure 2. Market Comparable Example

The ROK % calculates the value or benefits over costs ratio for each sub process in the flight scheduling process. The ROK % can then be used to determine which of these processes have the most and least value to the overall flight scheduling process so that changes could be made to improve upon the process. The sub processes were rank ordered by the VFA-14 Operations Officer based on complexity from least complex with the lower numbers to the most complex with the larger numbers. The complexity of the processes is also indicated by the actual learning time (ALT) column where the most complex tasks should take longer to learn.

The correlation between these columns is 90% which is a strong indication that the estimates attained are accurate as to the complexity of the sub processes and the time it takes to learn them. The %IT column identifies how much information technology is used to complete the process such as a word processing program or a specialized program designed and implemented specifically for a sub process such as risk assessment program. The ROK % can either be increased by decreasing the costs of a sub process (the denominator) or increasing the benefits of a sub process (the numerator). Any proposed changes to the current process that increase the ROK percentage should be verified to determine if the changes actually yielded an increase in value to the overall process or to a specific sub processes.

F. EXAMINING CHANGE TO THE PROCESS

With an analysis of the process using the KVA with market comparables methodology, a decision maker such as the squadron CO or the Wing Commander could examine the analysis and quickly determine where the most valuable and least valuable processes are located. The physical routing of the flight schedule for critique and approval has the lowest ROK% as this process is easy to learn as shown by the .5 Actual Learning Time (ALT), but is done by the Scheduling Officer who earns approximately $50,000 a year in salary.

In order to increase the value of this sub process, a lower cost employee could be employed to route the schedule such as a junior enlisted member or an electronic routing method such as email could be implemented to do the routing. This would increase the %IT utilized in this sub process and decrease the time to complete the sub process as physically routing a schedule is much slower than routing via some type of electric distribution. A decision maker can play what if scenarios with the process by changing the numbers to reflect proposed changes and the effects they would have on the ROK percentages.

The spreadsheet, denoted by Figure 3, is the same process with some proposed changes implemented to examine their effects on the ROK percentages and the overall process. The changes were selected based on several factors such as being reasonable to implement and if they would increase the ROK value of that sub process or the overall ROK ratio.

The first change is the Assistant Operations Officer was eliminated from the flight scheduling process. His sub processes of building the two and one week schedules were given to the Scheduling Officer since these sub processes must still be performed. His removal also eliminated one of the critiquing/approval sub processes from the entire process. The second change is the increased in % IT used to perform the schedule de-confliction by the Scheduling Officer. This assumes there is an IT capability that can provide this increase and is available for the Scheduling Officer to use.

The third change is to increase the % IT used by the NATOPS Officer to check the schedule for NATOPS violations. The fourth change is to increase the % IT used by the Training Officer to plan proficiency training that determines the scheduling of flights. The % IT increases for these sub processes assume the IT capability exists at no additional costs to the process such as a commercial off the shelf product already available and in use at the command, or a supported specialty program that has been underutilized. By implementing and using IT in processes, the affected processes will increase speed and the time it takes to complete them will decrease.[15] This would in turn lower the cost of the sub process and increase its ROK %.

The time to complete values for the affected sub processes in the spreadsheet below have been decreased based on this assumption. The decreased times would have to be measured in the actual sub process if the changes were implemented to confirm the estimates. The results of these changes and to the ROK percentages are contained below.

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	% IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	# of personnel	Annual Salary ($)	TLT x # fired x # of	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue /
Ops Officer	Study long range schedule	7	6		16	16	10	17.78	2	1	1	$100,000	17.78	0.16%	$15,021	$200,000	8%
	Conduct Firing Ranges scheduling	10	10		40	40	20	50.00	0.5	3	1	$100,000	150.00	1.38%	$126,743	$150,000	84%
	Critique/approve daily schedule	6	5		8	8	25	10.67	0.25	5	1	$100,000	53.33	0.49%	$45,064	$125,000	36%
Sched. Officer	Build 2 week schedule	9	8		40	40	50	80.00	2	0.5	1	$50,000	40.00	0.37%	$33,798	$50,000	68%
	Build 1 week schedule	5	4		8	8	50	16.00	1	1	1	$50,000	16.00	0.15%	$13,519	$50,000	27%
	Deconflict Daily schedule	14	18		160	160	90	1600.00	0.45	5	1	$50,000	8000.00	73.47%	$6,759,622	$112,500	6009%
	Create daily schedule	13	13		80	80	50	160.00	2	5	1	$50,000	800.00	7.35%	$675,962	$500,000	135%
	Route daily schedule for approval	1	0.5		0.5	0.5		0.50	0.5	5	1	$50,000	2.50	0.02%	$2,112	$125,000	2%
NATOPS	Update / Input pilot qualifications	2	1.5	20	4	24	30	34.29	0.5	5	1	$100,000	171.43	1.57%	$144,849	$250,000	58%
	Check schedule for NATOPS violations	3	2	20	4	24	90	240.00	0.25	5	1	$100,000	1200.00	11.02%	$1,013,943	$125,000	811%
Training Officer	Plan proficiency training syllabus	12	11	40	40	80	50	160.00	1	1	1	$100,000	160.00	1.47%	$135,192	$100,000	135%
	Integrate training syllabus in L.R. schedule	11	10.5		40	40	30	57.14	1	1	1	$100,000	57.14	0.52%	$48,283	$100,000	48%
	Daily review/update training syllabus	4	3.5		4	4		4.00	0.5	5	1	$100,000	20.00	0.18%	$16,899	$250,000	7%
CO	Critique/approve daily schedule	8	7	24	16	40		40.00	0.25	5	1	$125,000	200.00	1.84%	$168,991	$156,250	108%
	TOTAL		100										10888.18	100.00%	$9,200,000	$2,293,750	401%
	Correlation factor (NT-ALT)	0.894997															

Figure 3. Market Comparable Example (2)

The overall ROK percentage has increased from 327% to 401%. The overall cost of the entire process has decreased due to the elimination of the Assistant Operations Officer and one of his sub processes. The proposed changes appear to have an overall beneficial effect on the flight scheduling process; however, common sense would have to be applied to the changes to determine if they would make sense to implement them in the current process. Other organizational constraints may make any proposed changes unrealistic even though they made sense from a strictly financial perspective.

[15] O. El Sawy, et al., p. 38.

G. LIMITATIONS OF KVA AND MARKET COMPARABLES

The KVA methodology with market comparables approach is not without limitations. The first limitation is that many of the input values are based on estimates obtained from the responsible actors who are doing the process. If these estimates are incorrect due to a bias by the party giving them or the estimates were poorly measured, then the ROK values will be wrong leading to an incorrect analysis and faulty conclusions. It is human nature for one to desire protection of their job or process when under scrutiny. This could lead to unrealistic learning time estimates as the person under evaluation feels their job is so important or so difficult to learn, they provide inflated LT estimates to the researcher. This can be overcome if the process or job requires formal training that follows a standard period of education or training which provides a reliable unit of measurement. To the greatest extent possible, formal training evolutions were used as a measure of Learning Times during the research.

The second limitation is that assumptions must be made during the analysis of the process. If a faulty assumption is made or the conditions surrounding the assumption changes, the analysis could be incorrect and lead to incorrect ROK values. An example of an incorrect assumption would be the flight scheduling process occurs without error day in and day out where there is never a need for rework due to errors or omissions. If the time to complete estimates were based on this assumption and it was incorrect, then the times to complete could be underestimated because they do not take into account the rework time when one of the sub processes is completed in error and must be redone. By assuming there is some level of rework in the processes, the average time to complete a sub process is higher and thus accurately reflecting the actual sub process. This phenomenon was overcome by an extensive interviewing process and explicit parameters of measurement.

The third limitation of the methodology is the market comparables approach of allocating the revenue earned from a similar revenue generating process to a non-profit DoD process. The DoD does not generate revenue so it is difficult to allocate revenue across processes to determine the potential fiscal benefit of the process. The majority of the DoD's processes are so unique that one may argue that no direct comparisons can be made with any civilian for-profit organizations even if they appear similar. The comparison between AMC and UPS is an example of how even though the processes of delivering air cargo with similar aircraft along similar routes is highly similar, the two organizations costs structures and levels of efficiency are likely very different to afford a direct comparison.

The KVA and the market comparables approach mitigates some of these arguments by noting that the approach is only as good as its assumptions and estimates, and that the approach calls for comparables not direct comparisons, so they do not have to be exact.[16] The value of the approach is that even with its limitations it gives decision makers a method for quantifying the value from knowledge in their organizations and processes. When applied to DoD processes, it should not be the solely relied upon analysis tool before making changes to a process. Common sense and experience in addition to other analysis methods should be factored into the decision making process.

H. APPLICABILITY TO DOD

The methodology has value to DoD decision makers and resource sponsors; in that it is an objective analysis tool that can be utilized on nearly any Defense Department process to determine its complexity and the value of the overall process and its sub processes. The KVA methodology with market comparable approach is not meant to revolutionize the way DoD evaluates its processes or the decisions that should be made after a KVA analysis has been completed on a process. However, many times resource decisions are made under subjective assumptions without any analysis to support the decisions. Political considerations are one of the factors to blame for these non-objective decisions regarding what kind of defense programs to fund and what to cut.[17]

An example of this, using the previously mentioned flight scheduling KVA analysis, is the decision to keep the Assistant Operations Officer in the flight scheduling process. Without the analysis, a squadron CO might conclude since the Assistant Operations Officer is a “good” guy, his input is valuable to the overall process and his contributions appear to be important. After the above KVA analysis, the same CO now has a more objective analysis to determine if the Assistant Operations Officer’s

[16] Shannon P. Pratt, Robert F. Reilly, Robert P. Schweihs, 2000. Valuing a Business, p. 45.

[17] Philip J. Candreva, L. R. Jones, Armed Forces and Society, October 2005. “Congressional Control over Defense and Delegation of Authority in the Case of the Defense Emergency Fund,” p. 108.

contributions are worthwhile to the overall process or if he could be removed from the process and assigned other duties. KVA with market comparable helps to provide this objective analysis to prevent unsubstantiated decisions about whether a process should be eliminated, increased, or changed.

A KVA with market comparables analysis may be useful to DoD decision makers to help manage the effects of across the board budget cuts mandated by major claimants and other resource providers. When managers are tasked with such a mandate, a KVA analysis may help show that a cut to a particular process is not advisable due to the high value of the process. The same analysis may show that if a cut has to be taken, more of the cut should be taken in the lower value programs and processes while protecting the higher value programs as shown by the analysis. The all too familiar "10% across all commands" cut could now be taken 25% in one command and 5% in other commands to achieve the same overall 10%, while protecting the most valuable processes.

These are just some of the possibilities KVA and the market comparables approach could do for the DoD. The methodology would have to be more widely accepted across the DoD and users of the methodology would require formalized training in how to do a KVA analysis. The methodology would have to be developed and tailored for use in the DoD, but if it became a generally accepted application, it would give DoD managers an objective analysis tool to determine the value in DoD processes that when weighed against other considerations would help decision makers make the best possible resource decisions to support our military's programs.

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III. VFA-14 CASE STUDY

A. THE PROJECT GOAL

The purpose of the project is to look at the current, "As-Is", VFA-14 flight scheduling process driven by the Operations Department and denote how this process interacts with key squadron actors who have an input into this process. Once the "As-Is" has been fully explored and understood, Business Process Re-engineering (BPR) techniques will be utilized to come up with two possible solutions, an incremental "To-Be" solution and a "Radical" solution for how the process can be improved based on the value of the whole process and each sub-process that goes into the generation of the flight schedule.

The value of the process and sub-processes will be determined using the Knowledge-Value-Added (KVA) methodology authored by Dr. Housel and Bell. The "To-Be" solution is intended to be incremental improvements that can be implemented quickly and easily without a major change to the organization or the whole process; yet generate an immediate improvement in the value of the overall process. The "Radical" solution is intended to be a major paradigm shift in how the overall process is performed and the roles and responsibilities of each actor in the process. The "Radical" solution is intended to be a much more difficult solution to implement, taking longer to do, while calling on more techniques of BPR, but generate larger increases in the value of the overall process and affected sub-processes.

Finally, the concept of a "Super-Radical" process is introduced as a direction the squadron scheduling process could explore to generate an even further improvement in the process. The "Super-Radical" is only a concept to get stakeholders and decision makers to think about possibilities for the future. It may not be a feasible solution to implement now or even in the immediate future due to technology or political constraints on the current process. It is meant to get stakeholders to think out of the box in order to foster new ideas for Business Process Reengineering.

The research team used the Microsoft Visio program to generate the "As-Is", "To-Be", "Radical", and "Super Radical" process flow charts in order to understand the current process via a visual representation and then generate a visual presentation of what the subsequent iterations would look like. Visio helped identify the inputs, outputs, and how the various actors affected these throughout the process.

Microsoft Excel is used to generate and calculate the values for our KVA analysis. The KVA methodology enables us to identify and assess the value of the organization by putting the people and processes into common units of output. From these common units, performance ratios can then be calculated called the Return on Knowledge (ROK). With these ROK percentages, we were able to assess which people and sub-processes in the flight scheduling process are the most valuable and identify the sub-processes with the least value in order to implement BPR techniques to increase the value of the overall process.

Another item worth mentioning is that just as in the actual physical boundaries of the Squadron, there lays a natural division between the two departments of Operations (OPS) and Maintenance. During the course of this research it became apparent that the two departments' processes would have to be looked at in parallel, at least initially. For simplicity's sake, the following processes associated with OPS and Maintenance will be described and explained in sequential order, As-Is, then the To-Be, followed by the Radical and Super Radical which will be discussed in the chapter regarding the use of Enterprise Resource Planning.

B. THE “AS-IS” PROCESS FLOWCHART

The “As-Is” process (the current process in place) was generated in Microsoft Visio and determined from the team’s experience as military officers and two of the team members having directly worked with similar processes. Lieutenant Colonel Means is a Marine Corps aviator and has dealt directly with squadron operations and maintenance departments in various Marine Corps and Naval aviation squadrons. Lieutenant Jackson previously held a billet within the Maintenance Department of VFA-14; one of the squadrons used to study and model this process. He was able to provide Points of Contact and direct insight into how the squadron’s Operation’s Department and the flight scheduling process worked. Further, he was instrumental in the provision of Points of Contact located in the squadron that underwent interviews for validating the “As-Is” process.

Once the "As-Is" process was generated by the team, a research trip was scheduled for the purpose of validating the "As-Is" with VFA-14 squadron personnel. Validation and verification of the "As-Is" process flowchart occurred through personnel interviews with key stakeholders in the flight scheduling process such as the Operations Officer, Assistant Operations Officer, Training Officer, Scheduling Officer, and Operations Clerk. Once these interviews were conducted and their recommendations were implemented the "As-Is" process flowchart for Operations was generated below in Figure 4.

Figure 4 depicts the "As-Is" process flowchart the Operations department goes through to generate the daily flight schedule. The flight schedule takes approximately four hours to generate on average, but can take longer or shorter depending on availability of personnel, last minute changes, and rework. The overall process appears simple, however, its largely manual nature and redundancies cause it to execute in a less than optimal manner.

The main input to the schedule is a generic flight requirement. A flight requirement can be in many different forms and come from a variety of sources internal and external to the squadron. The box labeled "Inputs to Writing Schedule" contain all the main categories of a flight requirement input. These inputs all go to the Scheduling Officer (Scheds-O). The Schedules Officer will review the inputs and use them to generate the rough schedule. He must balance and de-conflict all of the flight requirements into an achievable schedule that will sustain a quality review by his superiors.

“As-Is” Process Flowchart (Operations Department)

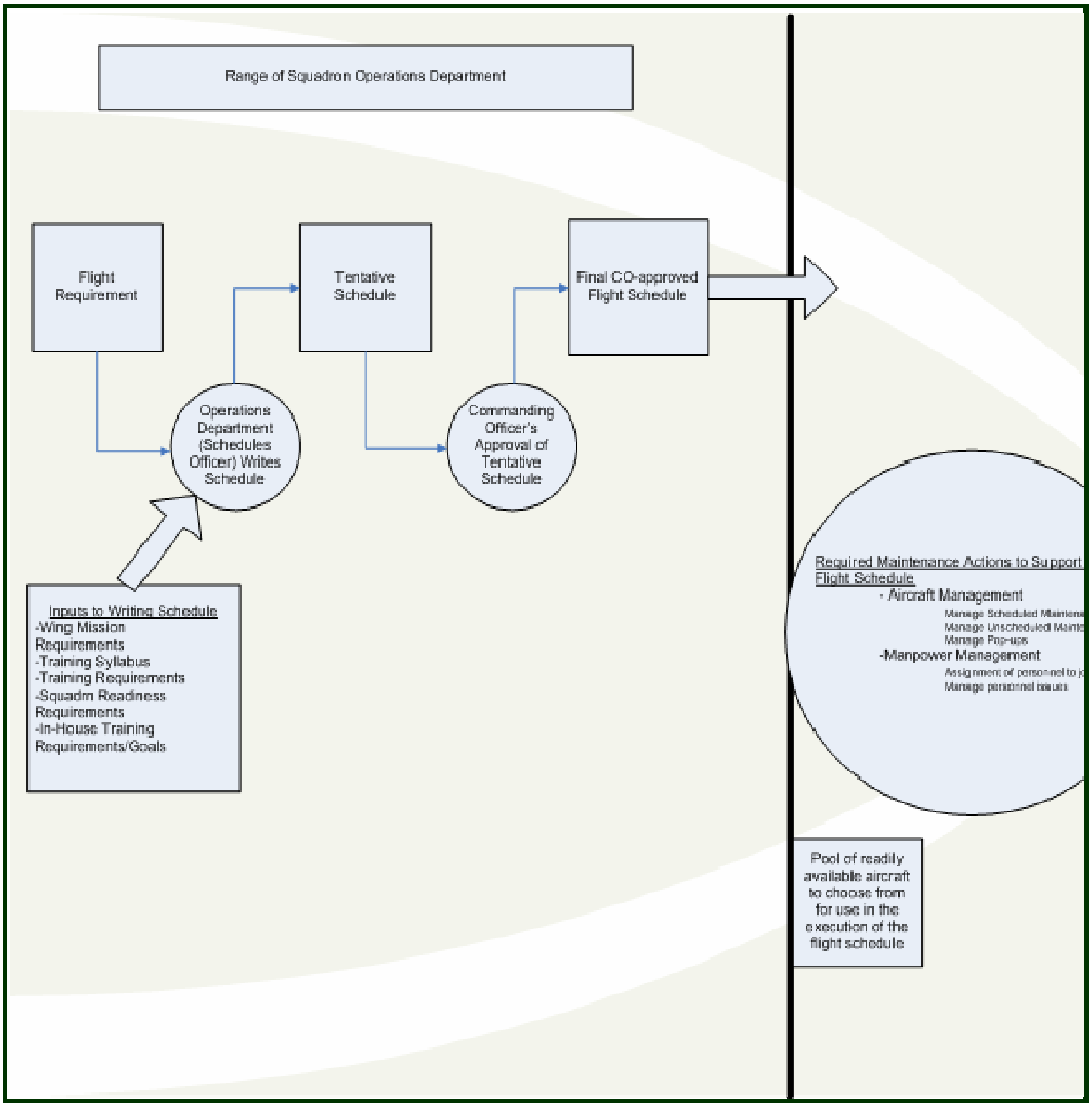

Figure 4. Operations Dept. Flowchart

Once the rough schedule is completed it is reviewed by the Assistant Operations Officer and the Operations Officer department head. It is then forwarded to the Commanding Officer for review and overall approval. The rough schedule is a paper schedule generated from a Microsoft Word template and is routed to the reviewing and approving personnel personally by the Schedules Officer. Delays and rework can occur if the reviewing and approving personnel detect errors in the schedule or omissions of flight requirements causing the Schedules Officer to go back to his work area, correct the deficiency and generate a new rough schedule.

A delay can also occur in the routing and approval of the schedule if one of the key actors in not available to perform their critique or approval. The Schedules Officer must then wait for this person to become available causing a delay to the entire process. Once the schedule is approved by the Commanding Officer, it is copied and distributed throughout the squadron and used as the plan for the next day's flight operations. The entire current process of producing a quality assured schedule is captured in the "As-Is" KVA spreadsheet depicted in Figure 5.

"AS-IS" KVA SPREADSHEET

Ops- As Is

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	% IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	Fired (per hr)	# of persons	Annual Salary ($)	Salary per hr ($)	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Ops Officer	Study long range schedule	8	6	0	16	16	10%	17.78	2	1	0.025	1	$100,000	$48	0.44	0.03%	$1.24	$2.40	52%
	Conduct Firing Ranges scheduling	11	10	0	40	40	20%	50.00	0.5	3	0.075	1	$100,000	$48	3.75	0.24%	$10.46	$1.80	580%
	Critique/approve daily schedule	7	5	0	8	8	25%	10.67	0.25	5	0.125	1	$100,000	$48	1.33	0.08%	$3.72	$1.50	248%
Asst Ops Officer	Build 2 week schedule	10	8	0	40	40	25%	53.33	2	0.5	0.0125	1	$80,000	$38	0.67	0.04%	$1.86	$0.96	193%
	Build 1 week schedule	6	4	0	8	8	25%	10.67	1	1	0.025	1	$80,000	$38	0.27	0.02%	$0.74	$0.96	77%
	Critique/approve daily schedule	2	1	0	2	2	15%	2.35	0.25	5	0.125	1	$80,000	$38	0.29	0.02%	$0.82	$1.20	68%
Sched. Officer	Deconflict Daily schedule	15	18	0	160	160	25%	213.33	1	5	0.125	1	$50,000	$24	26.67	1.68%	$74.40	$3.00	2476%
	Create daily schedule	14	12	0	80	80	25%	106.67	2	5	0.125	1	$50,000	$24	13.33	0.84%	$37.20	$6.01	619%
	Route daily schedule for approval	1	0.5	0	0.5	0.5	0%	0.50	0.5	5	0.125	1	$50,000	$24	0.06	0.00%	$0.17	$1.50	12%
NATOPS	Update / Input pilot qualifications	3	1.5	20	4	24	25%	32.00	0.5	5	0.125	1	$100,000	$48	4.00	0.25%	$11.16	$3.00	371%
	Check schedule for NATOPS violations	4	2	20	4	24	25%	32.00	0.5	5	0.125	1	$100,000	$48	4.00	0.25%	$11.16	$3.00	371%
Training Officer	Plan proficiency training syllabus	13	11	40	40	80	15%	94.12	2	1	0.025	1	$100,000	$48	2.35	0.15%	$6.57	$2.40	273%
	Integrate training syllabus in L.R. schedule	12	10.5	0	40	40	15%	47.06	1	1	0.025	1	$100,000	$48	1.18	0.07%	$3.28	$1.20	273%
	Daily review/update training syllabus	5	3.5	0	4	4	0%	4.00	0.5	5	0.125	1	$100,000	$48	0.50	0.03%	$1.40	$3.00	46%
CO	Critique/approve daily schedule	9	7	24	16	40	0%	40.00	0.25	5	0.125	1	$125,000	$60	5.00	0.32%	$13.95	$1.88	743%
	TOTAL		100			566.5		714.47	14.25						63.85	4.03%	$178	$34	526%
	Correlation factor (NT-ALT) 0.9002														1521.39				
															1585.24				

Assumptions
1 week = 40 hours
1 month = 4 weeks
1 year = 50 weeks = 2000 hours
Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus. .
CO attends a formal course that lasts 8 weeks but only 3 days (0.6 weeks) out of this 8 week LT are used to learn how to examine, review and critique the daily schedule
There is an explicit assumption that each officer that submits the schedule, submits it without mistakes and that he is not required to go back and redo it
There is an implicit assumption that there is perfect coordination among the officers that have to do with the schedule, including the CO, and so everyone knows what is required (no need to redo it because of, i.e. CO's vision was unclear)
Yearly Revenue $9,200,000 (4000 hours / year * $ 2300 hour = revenue = $ 9200000 aquired from NETJETS - Executive Jets Management)

time conversions:

weeks	days	hours	minutes
0.0125	0.0625	0.5	30
0.0188	0.0938	0.75	45
0.05	0.25	2	120
0.1	0.5	4	240
0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440

Figure 5. As-Is KVA spreadsheet

The "As-Is" KVA spreadsheet identifies the responsible actors and the sub-processes each actor is responsible for executing in order to generate the daily flight schedule. The assumptions the team is working with are listed below the spreadsheet. The input values to the spreadsheet such as Learning Time (LT), percent of Information Technology used (%IT), and Time to Complete were obtained from a combination of personal interviews conducted in person, via email, and via phone conversations with the actors in the flight scheduling process and the team's own experience with flight scheduling processes for a Navy aviation squadron.

The ROK % calculates the value or benefits over costs ratio for each sub-process in the flight scheduling process. The ROK % can then be used to determine which of these processes have the most and least value to the overall flight scheduling process so that BPR techniques can be used to improve upon the process. The rank order of the sub-processes, as given to the team from the VFA-14 Operations Officer, lists the processes based on complexity from least complex as denoted by lower numbers, to most complex as denoted by the larger numbers. The complexity of the processes is also indicated by the actual learning time (ALT) column where the most complex tasks should take longer to learn. The correlation between these columns is 90% which is a strong indication that the estimates attained are accurate as to the complexity of the sub-processes and the time it takes to learn them.

The %IT column identifies how Information Technology is used to complete the process; such as a word processing program or a specialized program designed and implemented specifically for a process such as a risk assessment program. The processes generally have a low IT percentage which could indicate a good opportunity to implement more IT into the process and possibly increase the ROK %. The ROK % can either be increased by decreasing the costs of the process (the denominator) or increasing the benefits of the process (the numerator). The proposed changes to the "As-Is" process that increase the ROK percentage would have to be tested to determine if the changes actually yielded and increase in value to the overall process or specific sub-processes. This is beyond the scope of this project and will not be measured.

The team came up with a revenue estimate using the Market Comparables approach. This allowed us to use the common and readily identifiable units of dollars in our numerator and denominator calculations to attain our ROK ratio. The revenue figure was attained from a company called Executive Jet Management, a Net-Jets company. The exact figures and the method utilized in the case study were discussed earlier in the Market Comparable section. As a reminder, the team utilized fixed revenue of $9.2M annually. The math used was $2300 of revenue per hour multiplied by the number of aircraft in the squadron, (12) F/A-18s. The squadron flies an average of 4000 hours per annum. 4000(hrs) X $2300 = $9.2M.

The following paragraphs describe the current processes as we discovered them to be after visiting the VFA-14 maintenance department during our research. Figure 6 depicts the "As-Is" process within the Maintenance Department. This process is one that occurs daily proportionally in support of the execution of the daily flight schedule in the form of unscheduled maintenance with the balance of the processes supporting previously scheduled maintenance.

The timeframe associated with the execution of the flight schedule, as far as the Maintenance Department is concerned, usually lasts about 24 hours on average. The beginning point is from the time that the current schedule was initially signed, until the next subsequent schedule is approved by the Commanding Officer.

The overall processes of the Maintenance Department, as is the case with the Operations Department, encompass more personnel and a greater number of operations than appears in the process of creating a flight schedule. However, similar to the processes used by the Operations Department involved in the creation of a flight schedule, the Maintenance Department processes also appear to be largely manual in nature. The fact that there are a substantially greater amount of processes increases the amount of human effort required, as well as the odds for creating larger returns with the implementation of refined business processes.

The Maintenance Department can be described as being in a reactionary role to the flight requirements as set by the Operations Department (OPS) within a squadron. Normally, OPS will collaborate with the Maintenance Department at least once, maybe even several times during the creation of a daily schedule in order to obtain a clear idea of whether or not there will be an adequate supply of aircraft available for the flight events that are being scheduled for the following day. In all instances though, all of the Maintenance Department efforts are concentrated upon meeting the future objectives as set forth by the Operations Department. There may, however, occasionally be instances when the objectives of a daily flight schedule are not able to be met. Additionally, rarely does a flight schedule ever execute that does not require several adjustments to be made to the published document.

In reference to the Maintenance Department flowchart (Figure 6), the input to the maintenance process begins with the approval of a flight schedule by the CO. Copies of the approved flight schedule in the current (As-Is) state of operations are normally hand-delivered to the Maintenance Department by the Operations Department. Distribution of the approved schedule amongst the Maintenance Department personnel includes everyone from the Maintenance Officer down to the each shop supervisor. It is not unusual to have to manually distribute as many as 25 hard-copies of the flight schedule throughout the Maintenance Department on a daily basis; a process that consumes a large amount of human and material resources. The flight schedule that is distributed pertains to the events that will occur the following day and serves as one of the primary inputs to the before-shift maintenance meeting.

Maintenance meetings are physically conducted prior to the beginning of each work shift. Most regular fleet squadrons conduct two maintenance shifts per day and these two shifts are commonly referred to as Day Check and Night Check.

Normally, the freshly approved schedule for the following day, when completed in time, will be part of the maintenance meeting in the sense that priorities will be set for which aircraft are to be concentrated on regarding the level of work effort. If the flight schedule isn't signed prior to the maintenance meeting, it simply comes into play when it is completed, and the Maintenance Control Chief Petty Officers (CPOs) will adjust the work effort as necessary.

"As-Is" Process Flowchart (Maintenance Department)

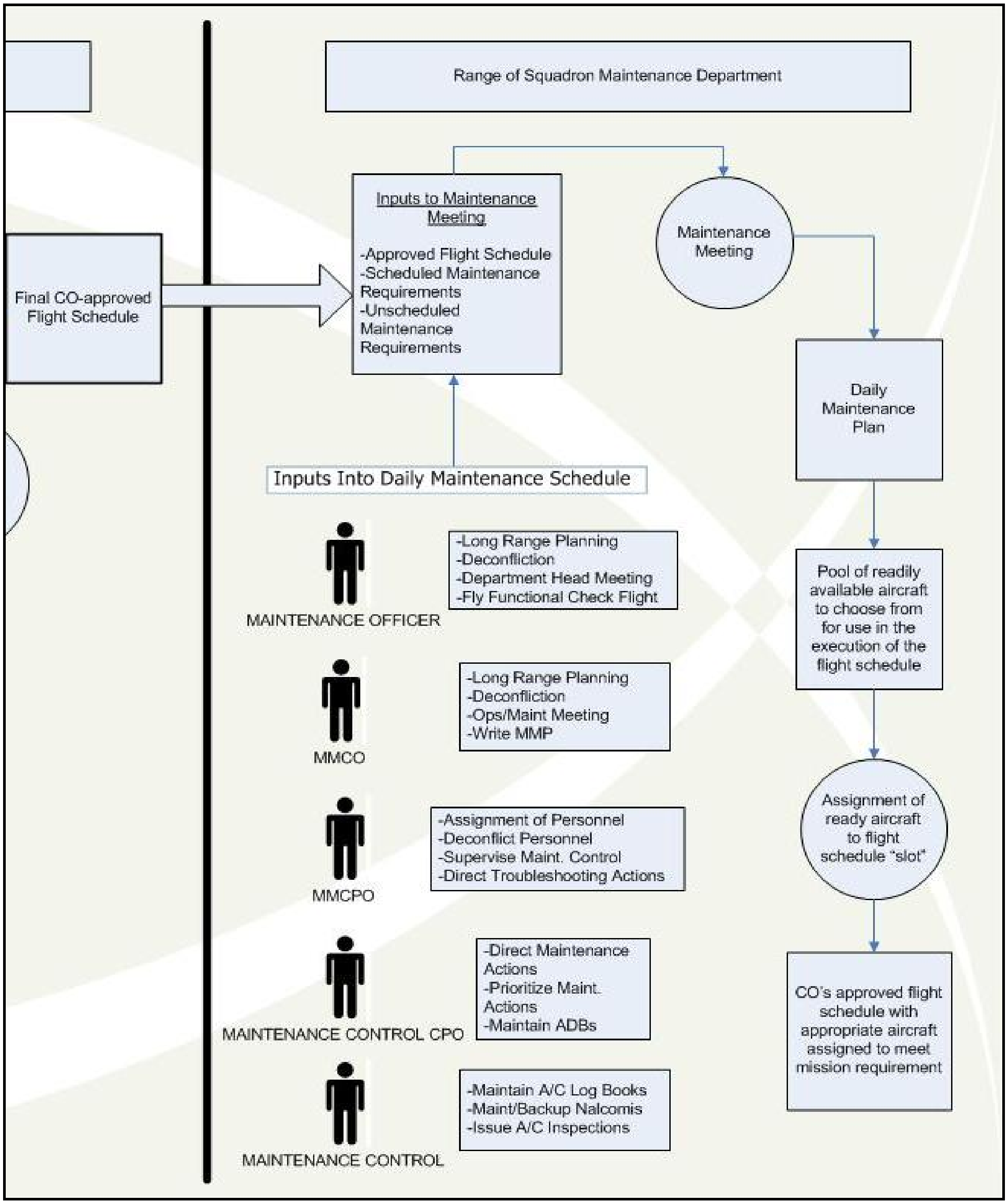

Figure 6. Maintenance Department Flowchart

The maintenance day begins with the commencement of the morning maintenance meeting. This meeting is proctored by the maintenance CPOs, and is attended by all maintenance division CPOs, work-center supervisors, the Maintenance Master Chief Petty Officer (MMCPO), the Maintenance/Material Control Officer (MMCO), and occasionally the Maintenance Officer (MO). During this meeting, the flight schedule is discussed and a plan of action to ensure its successful execution is formulated. Normally squadrons tend to fly 12 sorties per day in a training environment with planes departing in groups of three or four at a time. During the maintenance meeting, the goal of the planning evolution is to provide just enough planes to satisfy the requirements and balancing that with the remaining planes that maintenance action needs to be performed on. Additionally, plans for refueling and inspections between flights are finalized.

The maintenance meeting itself has very little IT involved. Essentially the only IT involved with the meeting is that of a computer printout of each work-centers current workload. This type of IT supplied information is indicative of just about all of the IT within the Maintenance Department. In other words, the IT is essentially giving back to you exactly what you put into it, there is little value added to the information as a result of the current type of IT being used within the squadron.

In addition to the flight schedule, there are other maintenance-specific requirements that are taken into account during the conduct of the maintenance meeting as well. These are known as scheduled and un-scheduled maintenance requirements. Scheduled requirements are those maintenance-related requirements that are part of a pre-established regimen based upon calendar or hourly intervals. These maintenance schedules are strictly adhered to on a daily basis and are always taken into account throughout the maintenance workday. Unscheduled inspections are exactly as they sound, they are not scheduled events. An example of unscheduled maintenance could be anything that occurs during a flight, such as a landing gear problem that generates and unexpected maintenance requirement. Other examples would be the resulting maintenance action required due to an aircraft experiencing a hard landing or other unforeseen circumstances.

With the approved schedule and inputs regarding scheduled and unscheduled maintenance, the maintenance meeting can be finished. As stated, the primary goals of the meeting are to discuss and formulate the plan for the successful execution of the flight schedule and secondarily to devise the plan for the completion of whatever maintenance priorities there are for that day.

The key to the successful management of the Maintenance Department depends heavily upon the balancing of scheduled flight requirements with that of the squadron's maintenance requirements, most of which happens with a relatively small amount of IT support in the current state.

C. MAINTENANCE DEPARTMENT ACTORS

At this point in time it is necessary to discuss the main personnel that make up the decision loop within the Maintenance Department. Figure 7 depicts the hierarchical structure of the Maintenance Department in a Navy aircraft squadron as stated in the OPNAV 4790 (series) manual.[18]

The Maintenance Officer (MO) is the officer that is in charge of, and is responsible for the overall accomplishment of the Maintenance Department's mission. Typically, in a Navy squadron, the MO is either an aviator or naval flight officer, normally a mid-grade Lieutenant Commander completing their department head tour. Additionally, the position of MO is usually a prerequisite to the position of OPSO as well, in order to allow the OPSO the opportunity to observe first hand the processes involved with the Maintenance Department.

[18] This manual, commonly referred to as "the 4790," is the primary source of Naval Aviation Maintenance doctrine. Within it, all aspects of policies and procedures related to the management of Naval Aviation Maintenance activities are discussed.

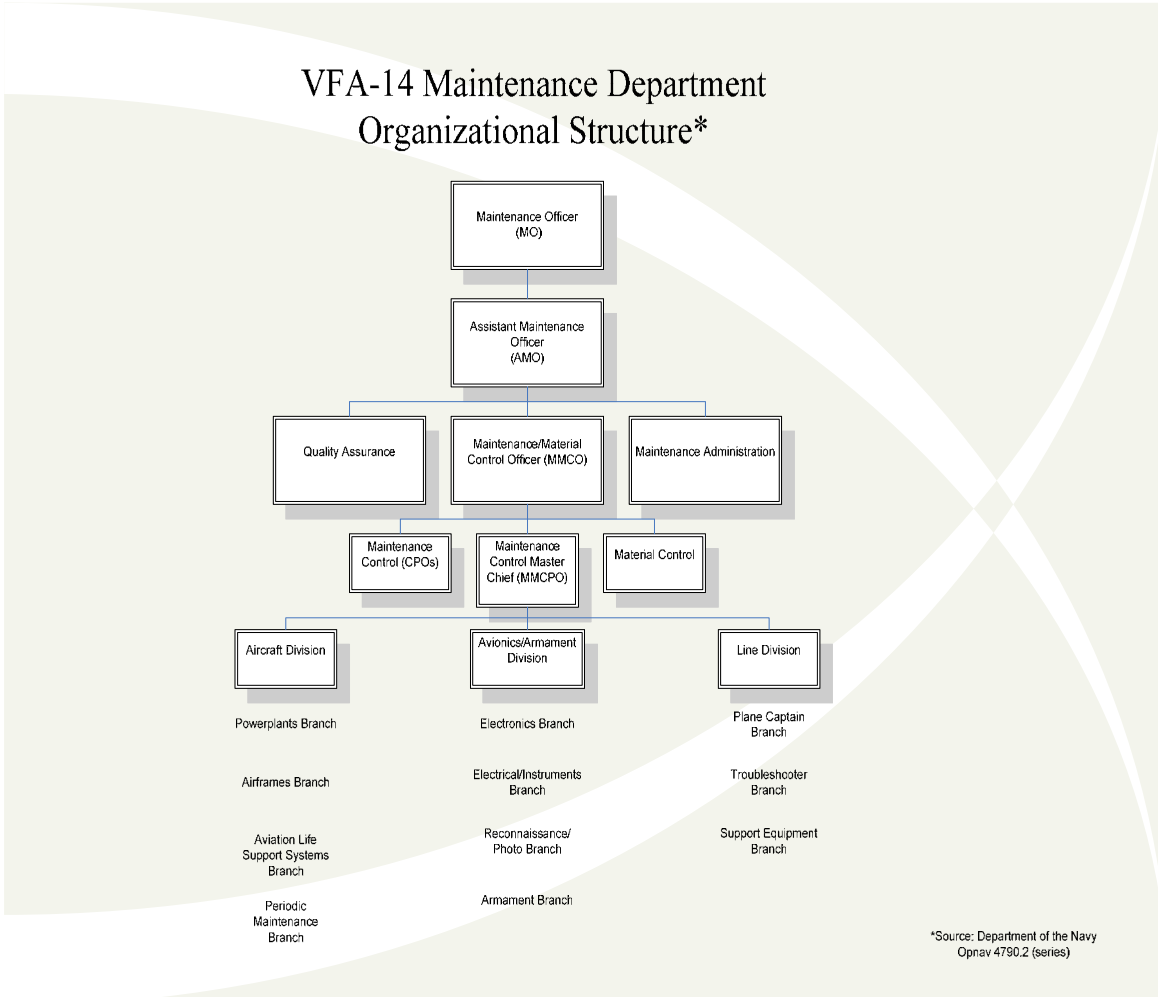

Figure 7. VFA-14 Maintenance Department Organizational Structure

Of note, the position of Assistant Maintenance Officer (AMO) was not considered to be an important position regarding the decision making process within the realm of the operational side of a Navy Maintenance Department. Although technically able to make "MO-level" decisions in the absence of the MO, the position of AMO is one that is administrative in nature. The AMO deals primarily with the management of various maintenance-related administrative programs, as well as maintenance related manpower issues.

Falling under the MO and AMO in the command structure is the position of Maintenance/Material Control Officer (MMCO). The position of MMCO is normally filled by a mid-grade Lieutenant or below including Warrant Officers, and is considered to be the position within the Maintenance Department that is most critical to its success. Whereas the MO holds the overall responsibility for what happens within the Maintenance Department, MMCO is the positional billet that operates mainly within the finer details of the maintenance and flight schedule execution process.

Under the MMCO is the Maintenance Master Chief Petty Officer (MMCPO). The MMCPO, not to be confused with the Command Master Chief Petty Officer (CMC), provides a sound knowledge base within the Maintenance Department that supplements the knowledge of the MMCO, the MO as well as the other CPOs within the department. Being the senior enlisted within the Maintenance Department, the MMCPO brings an average of 23-plus years of experience to the department that are crucial to the daily execution of all squadron maintenance functions.

The previously discussed positions (MO, AMO, MMCO and MMCPO) make up the senior level management structure within the Maintenance Department. Below that level lies what is referred to as Maintenance Control. Maintenance Control is the hub for all that happens within the Maintenance Department. All squadron maintenance actions are initiated by the Chief Petty Officers that work there, from scheduled and unscheduled maintenance to coordination of the physical execution of the flight schedule. Normally the people that make up Maintenance Control are mid-to-senior level Chief Petty Officers with previous experience as maintenance work center supervisors.

The last actor that was used in our research of the As-Is process was categorized as simply Maintenance Control, essentially capturing the efforts of those that work in conjunction with the Maintenance Control CPOs. The official Navy title of these actors are Aviation Maintenance Administration-men, and they are responsible for maintaining virtually all of the paperwork associated with being a controlling custodian of the aircraft.

The “As-Is” Maintenance KVA depicted on the spreadsheet in Figure 8, below lists each previously mentioned actor within the maintenance department and their respective duties, or sub-processes, that they are responsible for in the execution effort of the daily flight schedule and required aircraft maintenance actions.

“AS-IS” KVA SPREADSHEET (MAINTENANCE)

Maintenance- As Is

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	%IT	TLT Hours	Time to Complete (hours)	Times fired (per week)	Fired per hour	# of persons	Annual Salary ($)	Salary per hour	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Maintenance O	Long Range planning for Maint Actions	6	4	0	20	20	10%	22.22	1	5	0.125	1	$100,000	$48	2.78	0.18%	$7.75	$6.01	129%
	Deconflicts A/C avail vs Ops Flt Reqs	8	4	0	10	10	0%	10.00	0.25	20	0.5	1	$100,000	$48	5.00	0.32%	$13.95	$6.01	232%
	Department Head Meeting	14	2	0	2	2	0%	2.00	1	1	0.025	1	$100,000	$48	0.05	0.00%	$0.14	$1.20	12%
	Flys FCFs to increase A/C availability	13	3	0	10	10	0%	10.00	1	2	0.05	1	$100,000	$48	0.50	0.03%	$1.40	$2.40	58%
MMCO	Long Range planning for Maint Actions	4	6	6	30	36	10%	40.00	2	5	0.125	1	$80,000	$38	5.00	0.32%	$13.95	$9.62	145%
	Deconflicts A/C avail vs Ops Flt Reqs	3	6	6	15	21	0%	21.00	0.25	20	0.5	1	$80,000	$38	10.50	0.66%	$29.30	$4.81	609%
	Attends weekly OPS/MO Maint Meeting	9	3	0	2	2	0%	2.00	1	1	0.025	1	$80,000	$38	0.05	0.00%	$0.14	$0.96	15%
	Writes Monthly Maint Plan	10	4	2	3	5	30%	7.14	3	0.25	0.006	1	$80,000	$38	0.04	0.00%	$0.12	$0.72	17%
Maintenance Master Chief	Assigns Workcenter Personnel	7	5	16	5	21	10%	23.33	0.5	5	0.125	1	$78,000	$38	2.92	0.18%	$8.14	$2.34	347%
	Deconflicts Personnel TAD Requirements	12	3	0	1	1	10%	1.11	0.5	1	0.025	1	$78,000	$38	0.03	0.00%	$0.08	$0.47	17%
	Supervises Maint Control	2	12	48	20	68	10%	75.56	0.25	40	1	1	$78,000	$38	75.56	4.77%	$210.81	$9.38	2249%
	Directs Troubleshooting Maint Actions	11	4	16	10	26	10%	28.89	0.083	25	0.625	1	$78,000	$38	18.06	1.14%	$50.38	$1.95	2590%
Maintenance Control CPO	Directs Maint Actions to support Flt Sched	1	14	40	40	80	30%	114.29	0.05	133.3	3.333	3	$60,000	$29	1142.86	72.09%	$3,188.76	$14.42	22109%
	Prioritizes Workcenters efforts (ea shift)	5	5	0	5	5	30%	7.14	1.25	10.00	0.25	3	$60,000	$29	5.36	0.34%	$14.95	$27.04	55%
	Maintenance ADB's (A/C discrepancy books)	16	5	20	5	25	50%	50.00	0.033	25	0.625	3	$60,000	$29	93.75	5.91%	$261.58	$1.78	14655%
Maintenance Control	Maintain A/C log books	15	11	50	40	90	10%	100.00	0.16	60	1.5	1	$32,000	$15	150.00	9.46%	$418.52	$3.69	11335%
	Maintenance and upkeep of Nalcomis	17	3	5	10	15	0%	15.00	0.5	10	0.25	1	$32,000	$15	3.75	0.24%	$10.46	$1.92	544%
	Issue A/C & GSE inspections to workcenters	18	6	50	2	52	75%	208.00	0.5	1	0.025	1	$32,000	$15	5.20	0.33%	$14.51	$0.19	7545%
	TOTAL		100			489		737.68	13.326					$629	1521.39	95.97%	$4,245	$95	4472%
	Correlation factor (NT-ALT) 0.92														63.85				
															1585.24		$ 4,423.08		

Assumptions

1 week = 40 hours

1 month = 4 weeks

1 year = 50 weeks = 2000 hours

Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus. .

CO attends a formal course that lasts 8 weeks but only 3 days (0.6 weeks) out of this 8 week LT are used to learn how to examine, review and critique the daily schedule

There is an explicit assumption that each officer that submits the schedule, submits it without mistakes and that he is not required to go back and redo it

There is an implicit assumption that there is perfect coordination among the officers that have to do with the schedule, including the CO, and so everyone knows what is required (no need to redo it because of, i.e. CO's vision was unclear)

Yearly Revenue $9,200,000 (4000 hours / year * $ 2300 hour = revenue = $ 9200000 aquired from NETJETS - Executive Jets Management)

time conversions:

weeks	days	hours	minutes
0.013	0.0625	0.5	30
0.019	0.0938	0.75	45
0.05	0.25	2	120
0.1	0.5	4	240
0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440
		0.16	10
		0.083	5

Figure 8. As-Is KVA Spreadsheet (Maintenance)

As previously mentioned, the assumptions the team is working with are listed on the spreadsheet and values listed on the spreadsheet such as Learning Time (LT), percent of IT utilization in the respective sub-process (%IT), and Time to Complete. All of the values presented in the spreadsheet DoD were obtained from a combination of personal interviews with the aforementioned leadership billets in the VFA-14 Maintenance Department, publicly available published information, and utilization of the research teams' own experience on the subject. Figure 9 depicts the formal training time for a typical naval aviation maintenance department.

Length of formal training required for maintenance shop personnel (not Line Division)

A-Schools	CNATTU	Total Average Training Required =	72 Days
8	44		or
46	38		575 Hours
79	31		
201	16		
43	33		
11	40		
30	1		
10	10		
39	5		
8	5		
80	5		
30	36		
40	26		
48	33		
	26		
	31		
	24		

Length of formal training required for Line Division personnel (not shop personnel)

A-Schools	CNATTU		Total Average Training Required =	16 Days
0	16	PC Training		or
0	**16**			128 Hours

Allocate 60/40 to Daily/Turnaround Inspection respectively (in hours) = 77 and 51

Length of formal training required for Maintenance Control CPOs (not M/C shop personnel)

CNATTU	
12	SUPERFAM
10	(E-555-0040) M/C Management
5	(E-555-0038) Maf/Scir
27	**Days**
or	
216	**Hours**

Length of formal training required for Maintenance Material Control Officers

NASC Whiting Field

48 days average for AMO School (two programs, 1 @ 70 Days and 1@ 25 days)

48 days = 380 hours

Length of formal training required for Maintenance Control Master Chief

CNATTU

12 days C-600-3210(gives 8800 nec)

Length of formal training required for Maintenance Control Personnel

A-Schools		Figure 33% spent on logbooks, 33% on issuing inspections, 33% Nalcomis
56	days	
56		

Figure 9. Maintenance Formal Training

Values given for formal learning times (LT) within the Maintenance Department were obtained from information regarding the required training for each of the actors in order to perform the processes of the billet held. This does not mean that they have not had additional formal training after assuming the billet, but that these values represent the minimum amount in hours of training required for assumption of the position. Although, for simplicity's sake it was not accounted for, in some cases there are individuals called Strikers that perform mostly OJT in lieu of formal training for the position. For the purposes of our research, the individuals referred to would have attended the required school for non-striker personnel.

The As-Is spreadsheet provides a baseline for the efficiency level for each of the current processes occurring within the Maintenance Department. As is the case with the flight scheduling process, the percent Return on Knowledge (% ROK) is a calculated ratio of benefits over cost for each of the sub-processes performed by an actor in the Maintenance Department in support of the execution of the flight schedule.

The % ROK column in the spreadsheet provides us with visual determinations of which of the actor/sub-process combinations provide the least amount of overall value to the flight schedule execution process within the Maintenance Department. A visual determination of the ROK gives us a realistic view of the sub-process and its overall benefit using knowledge as a basis of measurement. From this, processes may be reorganized along with the introduction of IT so that the maximum Return On Investment (ROI) is achieved within the organization.

The rank order of the maintenance sub-processes was provided to the team from a combination of actors; the VFA-14 MO, the MMCO, and the MMCPO. The rank order column lists the processes based on complexity from least complex to most complex. The values in this column may be described by stating that the lesser complex processes are represented by a lower number and the more complex processes are represented by a higher number.

The relative complexity of these sub-processes are also indicated by the actual learning time (ALT) column, with the idea being that the most complex tasks should take longer to learn and lesser complex tasks not requiring as much learning time. The correlation between these columns is 90% which is a strong indication that the estimates attained are accurate as to the complexity of the sub-processes and the time it takes to learn them.

D. OUR SOLUTIONS

The research team came up with two solutions or changes to the “As-Is” process that would increase the overall ROK% of the entire flight scheduling process. The first solution is called the Incremental “To-Be” solution. The “To-Be” is designed to be easy and quick to implement into the “As-Is” process without much redesign. The positive side of this solution is that the pain that can come with change should be very low to the squadron as this solution is implemented. The drawback to this solution is that it affords only a minor increase in the overall ROK percentage to the flight scheduling process. This is a realistic and feasible solution if VFA-14 wants to make a slight improvement for their flight scheduling process that can be implemented without much difficulty or disruption to their overall process.

It is assumed that the “To-Be” solution could be implemented in the squadron with the least amount of disruption, least cost, and least effort. This solution could be implemented utilizing the current IT support available in the squadron.

The second possible solution involving a more pronounced change to the process model and requiring Business Process Engineering is called the “Radical” solution as depicted in Figure 10. The radical solution is based on an assumption of acceptance of BPR by the squadron and its personnel. All assumptions used to create the spreadsheet for the Radical are listed below the outcomes on the spreadsheet. The Radical KVA spreadsheet is discussed in further detail under the Radical subheading during the discussion of Enterprise Resource Planning (ERP).

"RADICAL" KVA SPREADSHEET

Ops- Radical

COG	Subprocess	LT (hours)	OJT (hours)	ALT (hours)	%IT/value of IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	Fired (per hr)	# of personnel	Annual Salary ($)	Salary per hr ($)	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Ops Officer	Input long range schedule into ERP	8	16	24	80%	120.00	0.016	0.08	0.002	1	$100,000	$48	0.24	0.01%	$0	$0	21554%
	Conduct Firing Ranges scheduling	8	8	16	80%	80.00	0.5	3	0.075	1	$100,000	$48	6	0.19%	$8	$2	460%
	Update long range schedule into ERP	0	8	8	80%	40.00	0.5	5	0.125	1	$100,000	$48	5	0.16%	$7	$3	230%
	Deconflict Schedule	0	0	0	210	210.00	0.016	5	0.125	1	$0	$0	26.25	0.82%	$36	$0	
	Generate Schedule	0	0	0	250	250.00	0.016	5	0.125	1	$0	$0	31.25	0.98%	$43	$0	
	Distribute Schedule	0	0	0	75	75.00	0.016	5	0.125	1	$0	$0	9.375	0.29%	$13	$0	
NATOPS	Update / Input pilot qualifications	8	8	16	80%	80.00	0.25	5	0.125	1	$100,000	$48	10	0.31%	$14	$2	920%
	Check Schedule for NATOPS violations	0	0	0	200	200.00	0.016	5	0.125	1	$0	$0	25	0.78%	$35	$0	
Training Officer	Input training syllabus into ERP	8	16	24	80%	120.00	0.016	0.08	0.002	1	$100,000	$48	0.24	0.01%	$0	$0	21554%
	Update training schedule into ERP	0	8	8	80%	40.00	0.5	5	0.125	1	$100,000	$48	5	0.16%	$7	$3	230%
CO	Critique/approve daily schedule	8	16	24	80%	120.00	0.25	5	0.125	1	$125,000	$60	15	0.47%	$21	$2	1104%
	Schedule Distribution	0	0	0	50	50.00	0.016	5	0.125	1	$0	$0	6.25	0.20%	$9	$0	
TOTAL				120		1385.00	2.112						139.605	4.36%	$193	$11	1723%
													3061.64				
													3201.24429				

Assumptions
1 week = 40 hours
1 month = 4 weeks
1 year = 50 weeks = 2000 hours
Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus
There is an explicit assumption that each officer that submits the schedule, submits it without mistakes and that he is not required to go back and redo it
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Yearly Revenue **$9,200,000** (4000 hours / year * $ 2300 hour = revenue = $ 9200000 aquired from NETJETS - Executive Jets Management)

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0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440

Figure 10. Radical KVA Spreadsheet

E. BUSINESS PROCESS REENGINEERING

In recent times, with the advent of the information age and its effects on the way the Department of Defense operates on a day-to-day basis, along with the requirement for quicker processing of increasingly greater information, the utilization of Information Technology as a viable solution has found its niche within the structure of the Navy.

The requirement of implementing an IT solution within any organization conforms to the notion that processes will be affected in some way. Most times, the processes within an organization are in need of some improvement, if that was not the case, then there would be no use for the implementation of IT. In virtually every case where an automated process is to be replaced or augmented by a form of computerized technology, a requirement for alteration of current practices presents itself.

In the early 1980s, the ideas having to do with the implementation of Information Technology had begun to wane in popularity. It seemed that large amounts of money were being spent, with increasingly smaller amounts of return on its investment being realized. Several articles were published during that period that attempted to explain this phenomena, and researchers began to find during their analyses was in many instances, although the effort being made to implement the IT into current processes was successful, the very idea of doing so was the inherent problem. In other words, the realization became apparent that fundamental business processes needed to be changed prior to the introduction of any IT solution within an organization in order to help ensure success.

In 1993, a book published by Michael Hammer and James Champy was one of the first to make use of the term BPR, or Business Processes Review.[19] This book emphasized the idea that a reorganization of business practices was essential in organizations that were experiencing poor levels of performance. Following the publishing of their book and others like it, the benefits of BPR when coupled with implementation of IT solutions became increasingly better known, and during the 1990s it eventually became a standard business practice.

[19] M. Hammer, J. Champy: *Reengineering the Corporation: A Manifesto for Business Revolution*. 1st ed. Harper Business, New York, NY (1993), last accessed January 2006.

The following diagram[20] Figure 11, depicts the BPR process redesign phase within an organization. The process of conducting a business process re-design consists of essentially three phases; the scoping process, the modeling, analysis and re-design process, and the integrating planning process.

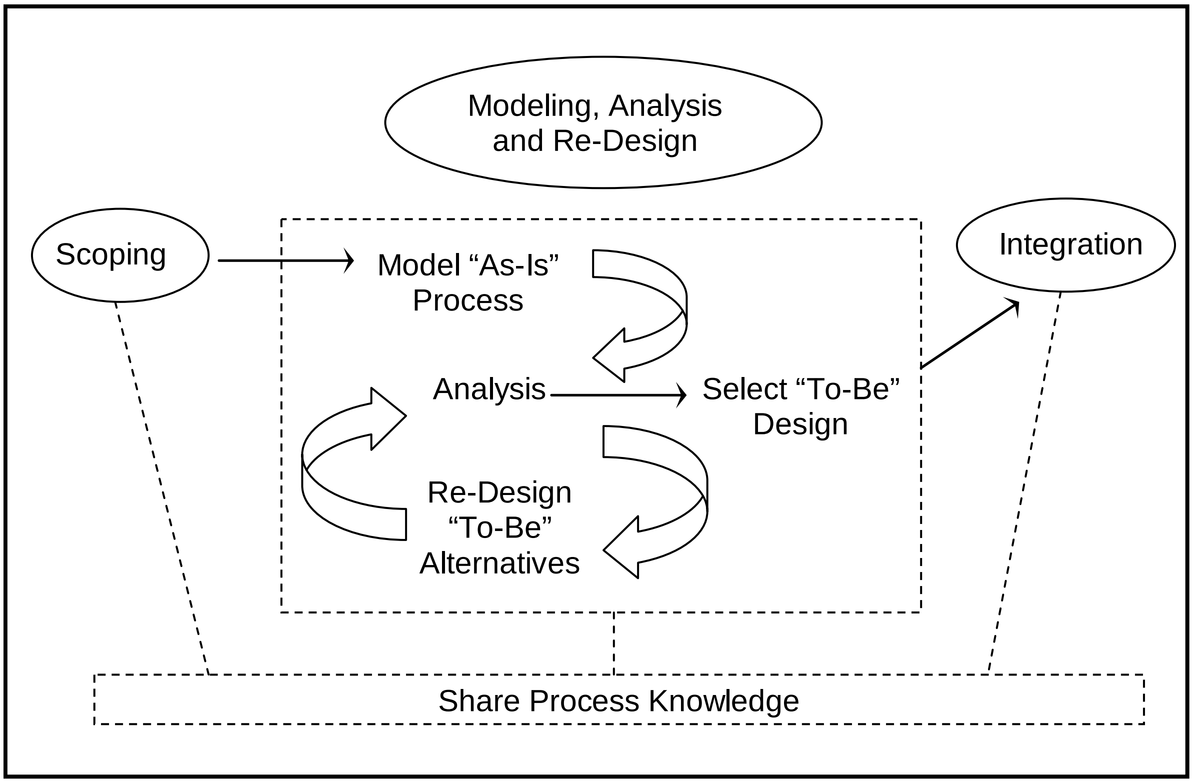

Figure 11. Business Process Review (BPR) Redesign Phase (From: El Sawy, 2001)

Each of the phases can be broken down into areas having to do with key tasks, deliverables and the identification of key participants within the organization. According to El Sawy, the phases required for any process reengineering effort is conducted as follows.

Phase one, the scoping process, involves such key tasks as identifying process boundaries and the key process issues. It is important that in this phase one understand the best practices of the organization, familiarize participants with the notion of BPR software and its capabilities, as well as to outline a plan for the collection of data and the formulation of the baseline. This phase would include a deliverable of a process scoping

[20] Omar A. El Sawy, Redesigning Enterprise Processes for e-Business, McGraw-Hill Irwin, 2001.

report and would involve such key participants as the process owners, the customers of the process, and the BPR implementation team. This phase ends with a plan for the modeling phase.

Phase 2, the modeling, analysis and redesign of the process phase begins with the development of a baseline called the “As-Is”. In this phase, the “As-Is” process is analyzed and diagnosed. From there, a “To-be model identifying process alternatives is developed. Analysis of the “To-be” is conducted and the best alternative is chosen. Finally, a software-based process model is developed and a process reengineering report is generated.

In phase 3, any alternative options are weighed, and any required adjustment of the process design is conducted, and a plan for process implantation is formulated. The final deliverable for all three phases is a process integration plan.

The main change in the “To-Be” process flowchart is the elimination of the Assistant Operations Officer actor in the process. This reduces the number of personnel who make inputs into the daily flight schedule and who review and critique the rough schedule before it reaches the Commanding Officer. The Assistant Operations Officer sub-process of critiquing and reviewing the daily flight schedule is eliminated and the sub-processes of building the two and one week schedules is now being done by the Schedules Officer who can complete these sub-processes at a lower cost thanks to a lower annual salary. This generates an overall cost savings to the entire process with a lower overall denominator which will be shown below in the “To-Be” spreadsheet.

F. “TO-BE” PROCESS FLOWCHART

The “To-Be” process flowchart contained in Figure 12 depicts the incremental changes to the process.

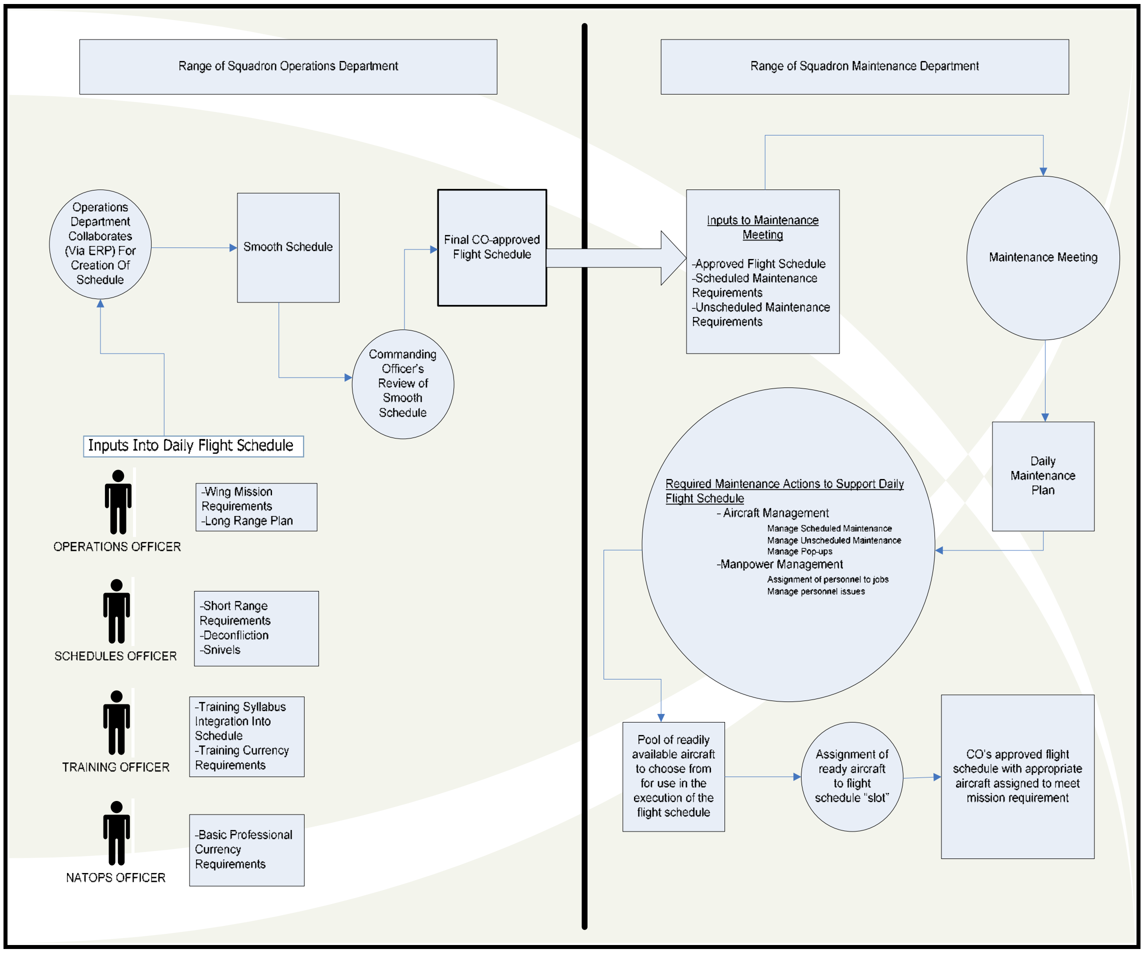

Figure 12. To-Be Flowchart

The additional changes the "To-Be" implements are an increased use of IT by the Schedules Officer for the collaboration of the inputs to generate the rough flight schedule. This can be implemented using stand alone Microsoft products such as email and excel or in house developed programs to assist the Schedules Officer in receiving and de-conflicting the inputs for the flight schedule. Another change would be to increase the percentage of IT used by the NATOPS and Training officer for their four sub-processes that utilize IT.

Their processes are relatively straight forward and stable, but are currently using a low amount of IT to complete. An increase in IT could be realistically achieved to facilitate the completion of their processes and increase the overall value of these sub-processes. This change in IT is not captured on the "To-Be" process flowchart since the inputs required for the process remains the same, but will be indicated on the "To-Be" KVA spreadsheet as the process parameters will change, e.g. time to complete will decrease due to the increase in % IT being utilized. The "To-Be" KVA spreadsheet capturing all of the changes suggested and their effects are depicted below in Figure 10.

The "To-Be" spreadsheet, Figure 13, shows the elimination of the Assistant Ops Officer to the flight scheduling process which eliminated his critiquing and approval of the rough flight schedule sub-process. The increases to the IT percentages are also shown for the Training Officer's and NATOPS Officers sub-processes which increased their ROK percentages. The overall increase in ROK for the whole process went up to 669% from the "AS-IS" total percent of 526%. This is a realistic increase in overall ROK % from the incremental changes made to the "AS-IS" process which are reflected in the "TO-BE" spreadsheet and flowchart.

"TO-BE" KVA SPREADSHEET

Ops- To Be

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	%IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	Fired (per hr)	# of personnel	Annual Salary ($)	Salary per hr ($)	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Ops Officer	Study long range schedule	7	6	0	16	16	10%	17.78	2	1	0.025	1	$100,000	$48	0.44	0.02%	$0.94	$2.40	39%
	Conduct Firing Ranges scheduling	10	10	0	40	40	20%	50.00	0.5	3	0.075	1	$100,000	$48	3.75	0.18%	$7.97	$1.80	442%
	Critique/approve daily schedule	6	5	0	8	8	25%	10.67	0.25	5	0.125	1	$100,000	$48	1.33	0.06%	$2.83	$1.50	189%
Sched. Officer	Build 2 week schedule	9	8	0	40	40	50%	80.00	2	0.5	0.0125	1	$50,000	$24	1.00	0.05%	$2.13	$0.60	354%
	Build 1 week schedule	5	4	0	8	8	50%	16.00	1	1	0.025	1	$50,000	$24	0.40	0.02%	$0.85	$0.60	142%
	Deconflict Daily schedule	14	18	0	160	160	50%	320.00	0.45	5	0.125	1	$50,000	$24	40.00	1.92%	$85.04	$1.35	6289%
	Create daily schedule	13	13	0	80	80	50%	160.00	2	5	0.125	1	$50,000	$24	20.00	0.96%	$42.52	$6.01	708%
	Route daily schedule for approval	1	0.5	0	0.5	0.5	0%	0.50	0.5	5	0.125	1	$50,000	$24	0.06	0.00%	$0.13	$1.50	9%
NATOPS	Update / Input pilot qualifications	2	1.5	20	4	24	30%	34.29	0.5	5	0.125	1	$100,000	$48	4.29	0.21%	$9.11	$3.00	303%
	Check schedule for NATOPS violations	3	2	20	4	24	50%	48.00	0.25	5	0.125	1	$100,000	$48	6.00	0.29%	$12.76	$1.50	849%
Training Officer	Plan proficiency training syllabus	12	11	40	40	80	25%	106.67	1	1	0.025	1	$100,000	$48	2.67	0.13%	$5.67	$1.20	472%
	Integrate training syllabus in L.R. schedule	11	10.5	0	40	40	25%	53.33	1	1	0.025	1	$100,000	$48	1.33	0.06%	$2.83	$1.20	236%
	Daily review/update training syllabus	4	3.5	0	4	4	0%	4.00	0.5	5	0.125	1	$100,000	$48	0.50	0.02%	$1.06	$3.00	35%
CO	Critique/approve daily schedule	8	7	24	16	40	0%	40.00	0.25	5	0.125	1	$125,000	$60	5.00	0.24%	$10.63	$1.88	566%
	TOTAL		100			564.5		941.23	12.2						86.78	4.17%	$184	$28	669%
	Correlation factor (NT-ALT) 0.894997														1993.66				
															2080.44				

Assumptions
1 week = 40 hours
1 month = 4 weeks
1 year = 50 weeks = 2000 hours
Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus. .
CO attends a formal course that lasts 8 weeks but only 3 days (0.6 weeks) out of this 8 week LT are used to learn how to examine, review and critique the daily schedule
There is an explicit assumption that each officer that submits the schedule, submits it without mistakes and that he is not required to go back and redo it
There is an implicit assumption that there is perfect coordination among the officers that have to do with the schedule, including the CO, and so everyone knows what is required (no need to redo it because of, i.e. CO's vision was unclear)
Yearly Revenue $9,200,000 (4000 hours / year * $ 2300 hour = revenue = $ 9200000 aquired from NETJETS - Executive Jets Management)

time conversions:

weeks	days	hours	minutes
0.0125	0.0625	0.5	30
0.01875	0.09375	0.75	45
0.05	0.25	2	120
0.1	0.5	4	240
0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440

Figure 13. Operations To-Be KVA Spreadsheet

The Maintenance “To-Be” flowchart depicted in Figure 14 shows the elimination of three tasks held by the Maintenance Officer in the “As-Is” scenario. Upon our investigation of the way the squadron operates within the Maintenance Department, we discovered that there is quite a bit of duplication of effort regarding certain tasks. As a disclaimer to the way the military operates and for the sake of research, we decided to eliminate some of these tasks that are duplicative in nature, but realize that for these changes to actually be incorporated, it would require a significant change in established policy.

"TO-BE" PROCESS FLOWCHART (MAINTENANCE)

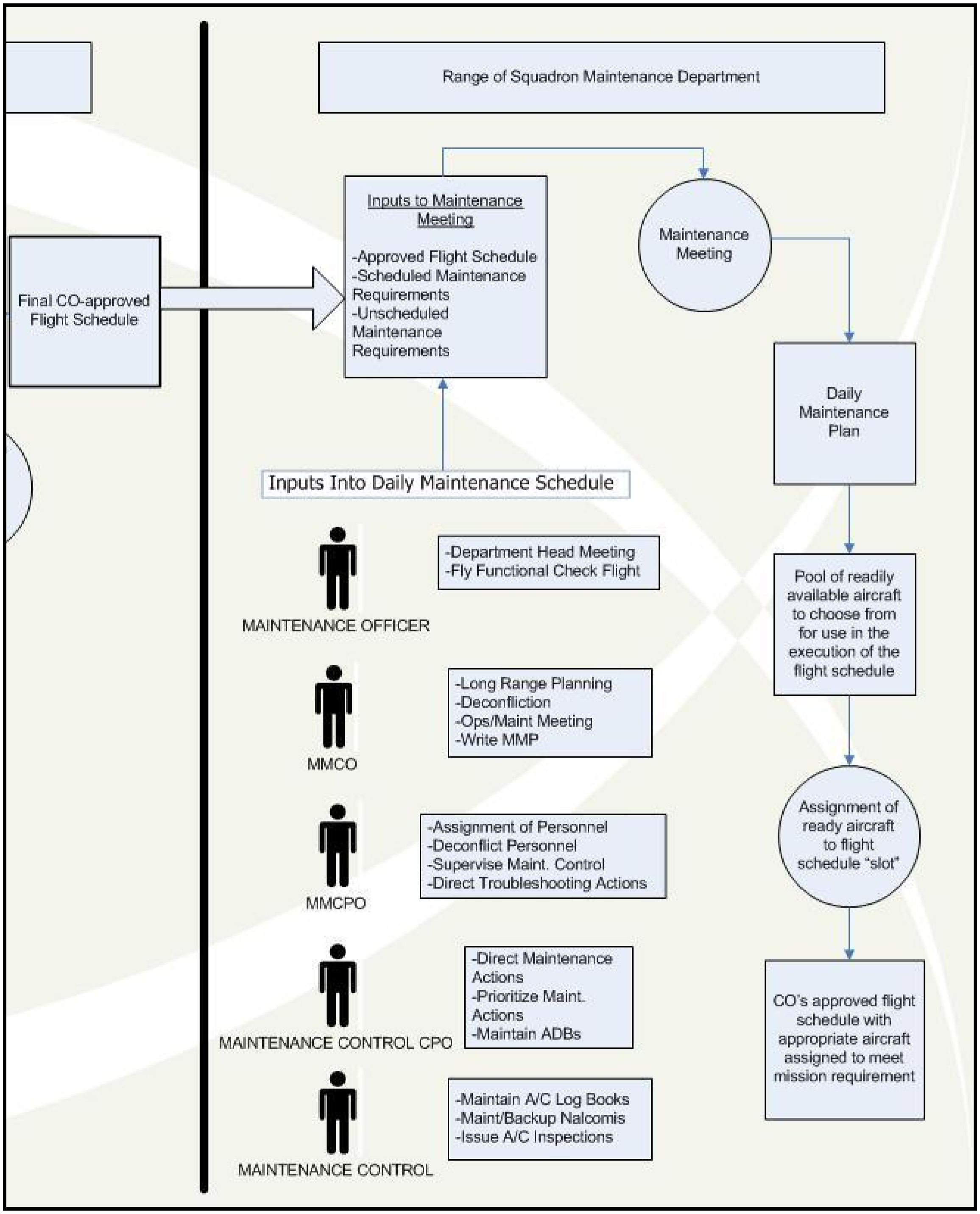

Figure 14. To-Be Flowchart (Maintenance)

The first change that we incorporated for the Maintenance Officer was to take away the subtask of long-range planning of maintenance actions, as this task is already performed by the MMCO. The 4790 states that the MMCO shall keep the MO advised of the overall workload and material situations as it affects the Maintenance Department.[21] Although the MO is overall responsible for the department, his responsibilities to the department are on a rather high level, thus our reasoning for leaving the long-range maintenance planning as primarily an MMCO responsibility. In reality that is not too far fetched- the MO primarily acts as an advisor to the MMCO on a high level, providing the direction, with the MMCO developing the plans.

Next, we decided to also make the task of de-conflicting aircraft availability versus flight requirements a task exclusively one that is performed by the MMCO. In all cases, the MMCO is the one performing this task anyway, so this task is really one that is especially duplicative in nature. The MO rarely gets “in the weeds” concerning day-to-day, flight-to-flight decisions unless something happens that severely disrupts the execution of the flight schedule. It is understood that the MMCOs professional background and support staff is more than adequate in ensuring that de-confliction of aircraft versus flight requirements happens in an accurate and timely manner.

Regarding the rest of the actors within the Maintenance Department (MMCO, MMCPO, Maintenance Control CPOs, and Maintenance Control Personnel) we were not able to justify the elimination of any additional tasks in the to-be scenario. We were, however, able to affect the “To-Be” by increasing the amount of IT involved with almost all of the tasks in the “To-Be” scenario.

Relatively speaking, the Maintenance Department as a whole is largely an organization that depends on little automation in order to function. Historically, the Maintenance Department in a squadron has relied on carbon-copy forms for virtually all of its maintenance documentation. It wasn't until the early 1990's, with the introduction of the Naval Aviation Logistics Command Management Information System (NALCOMIS), that there was any automation to the process within the department at all. Even with the introduction of NALCOMIS, there is still a relatively minute amount of

[21] 4790 Vol. 1 Chapter 11, p. 13.

useful IT within Navy aircraft squadrons. Only now, as of this publication, is a newer Windows-based version of NALCOMIS undergoing testing in select squadrons with a fleet-wide release that is still unknown.

In the “To-Be” scenario, we believe the percentage of IT could readily be increased in the following areas.

1. Maintenance Officer

The current “As-Is” state of the department head meeting relies on virtually little, if any IT. It is feasible to believe that the process could easily undergo some update involving automation using collaborative technologies such as virtual meetings. These technologies allow for more accurate processing and dissemination of information (i.e. the meeting minutes) as a result of the meeting as well as the ability to conduct remote meetings when the need arises.

2. MMCO and MMCPO

The MMCO and the MMCPO both utilize little IT in the “As-Is” scenario. NALCOMIS is the only program other than commercially available software such as Microsoft Excel that are currently being used to document and maintain maintenance specific tasks and events. Certain tasks that both of these actors perform will likely never benefit from a large percentage of IT, such as the tasks involving direct supervision of maintenance personnel.

One item that was discovered during our research was that some of the squadrons are using at least one proprietary program, a Microsoft Access Database, for use in tracking several things ranging from personnel information and qualifications to the monitoring of a worker's Temporary Additional Duty (TAD) status. From our research, we ascertained that the database was assembled by a Maintenance Officer for his own personal use some time ago and has since been passed around to different squadrons. This indicates an active desire for an IT solution that may possibly be going unanswered by the Navy at this time.

The use of proprietary software in this situation causes a couple of problems. The software is not approved for use by the Navy, and uses personal information (e.g. social security numbers) which is being stored in an unsecured environment. Secondly, although the use of a database for storing this kind of information allows for quick search methods, the fact that all of the databases are stand-alone is a limiting factor. An ideal situation would have a central portal that all squadrons at the same base, or in the same air wing, could access and be allowed permissions to retrieve and enter their information into a commonly shared database.

3. Maintenance Control Chief Petty Officers

The Maintenance Control Chief Petty Officer (CPO) billet is a key function within the Maintenance Department and currently utilizes the greatest percentage of IT in the current "As-Is" environment. However, similar to the MMCO and MMCPO, the Maintenance CPO utilizes NALCOMIS almost exclusively. In fact, we discovered that the Maintenance CPO always has one eye on the NALCOMIS terminal and one on a white board labeled with such things as colored arrows that indicate various conditions such as the status of each particular aircraft. Although the Maintenance Control CPO utilizes the greatest percentage of IT, relatively speaking, he is also relying on the greatest percentage of manual processes as well. The fact that a greater percentage of IT is being used is directly counteracted by the prevalent use of manual processes. The Maintenance Control CPO billet needs a suitable IT solution that will combine the multitude of current processes into a single process so that all of the relevant information is available with the least amount of effort.

4. Maintenance Control

This actor/billet category exists as a direct support function to the Maintenance Control CPO. During our interviews with the members of this work-center, we discovered that although these individuals are responsible for the upkeep and maintenance of NALCOMIS, they are burdened with a responsibility that could benefit the most from an introduction of an IT solution.

The sub-process of maintaining the aircraft logbooks is without a doubt the most burdensome position within the maintenance "front office". This process involves the manual use of an electric typewriter to make entries into each of the 12 aircraft logbooks on a daily basis. We provide a rather conservative estimate in our dataset that indicates an average of 90 entries per week is made.

Compliance of technical directives is the most labor intensive process for any logbook clerk working in Maintenance Control. Spanning categories within a logbook that include such items as the records associated with a myriad of aircraft components, or the items such as the mandatory compliance of Airframe ,Power-plant, Avionics, and Software engineering changes to the aircraft. A logbook clerk may have to annotate hundreds of this type of entries in each logbook. On of the largest areas of concern in any squadron is the annotation of compliance with Technical Directives, or TDs. Currently for the F/A-18E, the Navy's newest strike fighter jet, there are literally thousands of these TDs that have to be accounted for on each of the 12 aircraft that the squadron is responsible for.

These TDs are important because they relay instructions regarding the inspection and/or repair of items that manufacturing engineers have identified as important to the safety of the aircraft. Not only is the compliance with these TDs mandatory, their accuracy in reporting is as well. Since the annotation of compliance with TDs into the logbook is the job of the logbook clerk within the Maintenance Department, the lack of IT in the current state lends itself to the potential for errors, not to mention increased time to perform the manual process.

G. COMPARATIVE ASSESSMENT OF ALL MODELS

Figure 15 depicts the differences in two of the models, As-Is and the To-Be, and provides a visualization of all the changes that took place in an easy to ready side by side format. The Radical and the Super Radical will be discussed and depicted in later chapters dealing with the use of Enterprise Resource Planning.

COMPARATIVE ASSESSMENT OF MODELS

Function	Allocated Knowledge	Allocated Percent	Numerator	Denominator	ROK
AS-IS Ops	63.85	4.03%	$ 178.14	$ 33.85	526%
AS-IS Maintenance	1521.39	95.97%	$ 4,244.93	$ 94.92	4472%
	1585.24	100.00%	$ 4,423.08	$ 128.77	3435%
To-Be Ops	86.78	4.17%	$ 184.49	$ 27.57	669%
To-Be Maintenance	1993.66	95.83%	$ 4,238.59	$ 81.48	5202%
	2080.44	100.00%	$ 4,423.08	$ 109.05	4056%

Figure 15. Comparison of Models

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IV. ENTERPRISE RESOURCE PLANNING

A. IMPLEMENTING A SUCCESSFUL ERP

There are many important factors that must be considered when striving to achieve a successful ERP implementation into an organization. Three of the most important factors that an organization, whether it be the DoD or civilian, should concentrate on are the following: (1) A prepared organization accepting of the new change (2) A capable implementation team empowered to be flexible and implement the ERP rapidly, and (3) a focus on integration with the current and legacy ERP systems it will function with.

Assuming the organization has the infrastructure and IT staff to support the new ERP system, the organization must prepare itself for the new system through education and training of its employees. An ERP tool calls for a change in the way an organization does business. People, especially DoD personnel, can be very resistant to the change brought on by an ERP system. The organization must be sold on the value of the new system and its personnel must be trained in its use or it could sit as an unused icon on their desktop. This kind of buy-in starts from the top with the CO/XO and department heads supporting the new system and ensuring the training of the organizational layers below them. As the new system comes online, the leaders of the organization must ensure the new system is the only acceptable way of doing business from that point on; otherwise resisters to the change may work around the new program to avoid learning and using the ERP system. An ERP mission planning system to generate flight schedules in a squadron would not be widely accepted if the "old" chiefs of the squadron were allowed to continue to generate flight schedules using a previous manual method.

A second key factor to a successful ERP implementation is an implementation team who has the authority to make decisions and the ability to complete the installation of the system before the command or organization stops supporting the project. A common cause of ERP failures is the cost and time involved with the implementation, causing the organization to give up on the project before they have a chance to realize the benefits from the new system. An ERP implementation team needs to recognize this risk and mitigate it by executing a plan that will install the system and train the users on schedule and on budget before the organization loses faith in the new system. This team should be the system experts consisting of members from the organization and the outside entity providing the program to the command. Once the install is complete, the internal members will still be around to train users and support the value of the ERP when the external team members are gone. The team should have authority from the command to make decisions and changes regarding installation to overcome problems as quickly as possible and stay on schedule.

The third factor to achieving a successful ERP implementation is to concentrate on the integration of the new system with legacy systems. Integration concerns are some of the biggest challenges with the implementation of an ERP system. An ERP system must function seamlessly with legacy systems while executing the new processes it is designed to do. With all the different stove piped systems in the DoD's existence, this is a challenging task for an ERP system that must function across the DoD or even just the Navy.

The Global Transportation Network (GTN) is an example of an ERP that was implemented DoD wide to attain total asset visibility of material in the Defense Transportation System using a Transportation Control Number (TCN) as primary DoD input. This system had to pull data from all of the services organic material management and tracking programs as well as from civilian shipping companies like FEDEX and feed it into the GTN website. The databases of all these systems were each likely developed and coded uniquely and without much thought of integration as they were designed as stand alone systems.

The challenge of ERP integration is to recognize all these varying systems and data fields and be able to interpret them into the system without any compatibility issues. With all the possible combinations available to databases past and present, this could become a programming nightmare and illustrates the difficulty in getting different ERP systems to function with each other. Successful ERP integration between such systems removes these cross functional barriers and allows the information shared between them to be transferred seamlessly and efficiently.

Although there are many factors that must be considered for ERP implementation, an organization prepared and ready for ERP change, a solid implementation team and process, and successful integration with legacy systems are three of the key focal points for an organization to successfully implement an ERP solution into their processes. These areas will help an organization effectively manage the risk and get the process right the first time around.

The research team examined a real world example of the use of an ERP to facilitate aviation operations in an actual squadron. Currently the Israeli Armed Forces utilize a product from the Xvionics Corporation to aid in their daily decision making processes in a squadron that routinely flies actual bombing/attack missions on actual adversaries. The Israeli maintenance processes are shown in Figure 16. These processes and their associated data is a reflection of a typical Israeli aviation squadron's maintenance department.

Israeli Maintenance

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	% IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	Fired (per hr)	# of persons	Annual Salary ($)	Annual per hr ($)	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Maintenance O	Long Range planning for Maint Actions			8	10	18	50%	36.00	1	5	0.125	1	$60,000	$38	4.50	0.06%	$2	$5	52%
	Deconflicts A/C avail vs Ops Flt Reqs			0	10	10	99%	1000.00	0.25	12	0.3	1	$60,000	$38	300.00	3.76%	$166	$3	5762%
	Weekly OPS/MO/CO Maint Meeting			0	3	3	0%	3.00	1	1	0.025	1	$60,000	$38	0.08	0.00%	$0	$1	4%
	Flys FCFs to increase A/C availability			0	5	5	80%	25.00	0.5	2	0.05	1	$60,000	$38	1.25	0.02%	$1	$1	72%
	Attends Weekly Wing Maint Meeting			0	3	3	0%	3.00	1	1	0.025	1	$60,000	$38	0.08	0.00%	$0	$1	4%
MMCO	Long Range planning for Maint Actions			8	15	23	50%	46.00	1	5	0.125	3	$45,000	$29	17.25	0.22%	$10	$11	88%
	Deconflicts A/C avail vs Ops Flt Reqs			0	20	20	99%	2000.00	0.25	12	0.3	3	$45,000	$29	1800.00	22.55%	$997	$6	15364%
	Approves permission to fly and aircraft limitations			0	20	20	99%	2000.00	0.25	12	0.3	3	$45,000	$29	1800.00	22.55%	$997	$6	15364%
	Supervises Maint activities			8	36	44	50%	88.00	1	12	0.3	3	$45,000	$29	79.20	0.99%	$44	$26	169%
Maintenance Master Chief	Assigns Workcenter Personnel			4	8	12	70%	40.00	0.25	12	0.3	4	$40,000	$26	48.00	0.60%	$27	$8	346%
	Deconflicts Personnel TAD Requirements			0	2	2	50%	4.00	0.5	5	0.125	4	$40,000	$26	2.00	0.03%	$1	$6	17%
	Supervises Maint activities			16	24	40	50%	80.00	0.5	20	0.5	4	$40,000	$26	160.00	2.00%	$89	$26	346%
	Order specialist flight technicians to support Flt Sched			0	4	4	30%	5.71	0.25	12	0.3	4	$40,000	$26	6.86	0.09%	$4	$8	49%
	Directs Troubleshooting Maint Actions			4	24	28	20%	35.00	0.25	24	0.6	4	$40,000	$26	84.00	1.05%	$47	$15	302%
Maintenance Control CPO	Directs Maint Actions to support Flt Sched			4	60	64	99%	6400.00	0.25	12	0.3	1	$55,000	$35	1920.00	24.05%	$1,064	$3	40227%
	Prioritizes Workcenters efforts (ea shift)			0	10	10	80%	50.00	0.25	12	0.3	1	$55,000	$35	15.00	0.19%	$8	$3	314%
	Monitor A/C status, availability and serviceability			4	4	8	99%	800.00	0.5	20	0.5	1	$55,000	$35	400.00	5.01%	$222	$9	2514%
	Maintenance and upkeep of IT systems			8	16	24	99%	2400.00	0.5	20	0.5	1	$31,000	$20	1200.00	15.03%	$665	$5	13382%
	Issue A/C & GSE inspections to workcenters			4	8	12	80%	60.00	0.25	4	0.1	1	$31,000	$20	6.00	0.08%	$3	$0	669%
	TOTAL		0			350		15075.71							7844.21	0.982514	$4,346	$143	3045%
	Correlation factor (NT-ALT)	#DIV/0!													139.61				
															7,983.81				

Assumptions

1 week = 40 hours

1 month = 4 weeks

1 year = 50 weeks = 2000 hours

Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus. .

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0.0125	0.0625	0.5	30
0.01875	0.09375	0.75	45
0.05	0.25	2	120
0.1	0.5	4	240
0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440

Figure 16. Israeli Maintenance

The Israeli Air Force uses Xvionics program XV-OMS 3.0 to conduct mission planning and to generate their flight schedules. The XV-OMS 3.0 is an ERP and Decision Support System (DSS) program specifically designed to support command and control operations at the wing and squadron level. The program is in use in all thirty-five squadrons of the Israeli Air Force and has helped to reduce operating costs by approximately 25%, increase operational and combat efficiencies by approximately 125%, and has improved overall squadron safety.[22] The actors, processes and associated data are used as the input to generate the Navy maintenance radical figure. The Navy maintenance radical figure is a redesigned view of a Navy squadron's maintenance department with data and processes from the Israeli Air Force used as input. This is designed to show what a Navy aviation squadron's maintenance department would look like if it were using an ERP program like Xvionics XV-OMS 3.0 and the improvements gained in the ROK ratios. The Israeli maintenance figure and it data were obtained from a former active duty Israeli Air Force officer, Mr. Gamliel "Jicko" Shitrit. Mr. Shitrit served several operational tours in the Israeli Air Force up to the Executive Officer level and now works for Xvionics Inc. as the Director of Engineering.

B. IMPLEMENTING A "RADICAL" PROCESS CHANGE

In the case study of VFA-14 one is able to view how much further the implementation of an IT solution can be taken in the creation of efficiency. In addition to the To-Be solution, the team came up with a Radical and a Super Radical solution that involve increasing dependence upon IT to complete the processes inside of a U.S. Naval aviation squadron. When comparing the radical process flowchart with the "As-Is", the main changes can be found by viewing the main character changes that occurred in the Figure 17 flowchart depicted below.

Of note is the elimination of two characters that were heavily involved in supporting the business process through manual means with limited IT support. The Assistant Operations Officer and the Schedules Officer have been eliminated in favor of increasing the usage of IT in the process. This represents Business Process Engineering (BPR) via the incorporation of an Enterprise Resource Planning tool. The elimination of

[22] Xvionics Corporation, Xvionics fact sheet, p. 1. http://www.xvionics.com/downloads/XVionics_factsheet.pdf, last accessed 14 August 2006.

the two positions would save the unit approximately $130,000.00 in annual salary that would have been paid to the two positions. The BPR would require a change in the processes to fit the new ERP vice trying to make the ERP support the old processes. The end result or output is a signed and quality assured flight schedule that can be used to drive the squadron's mission requirements.

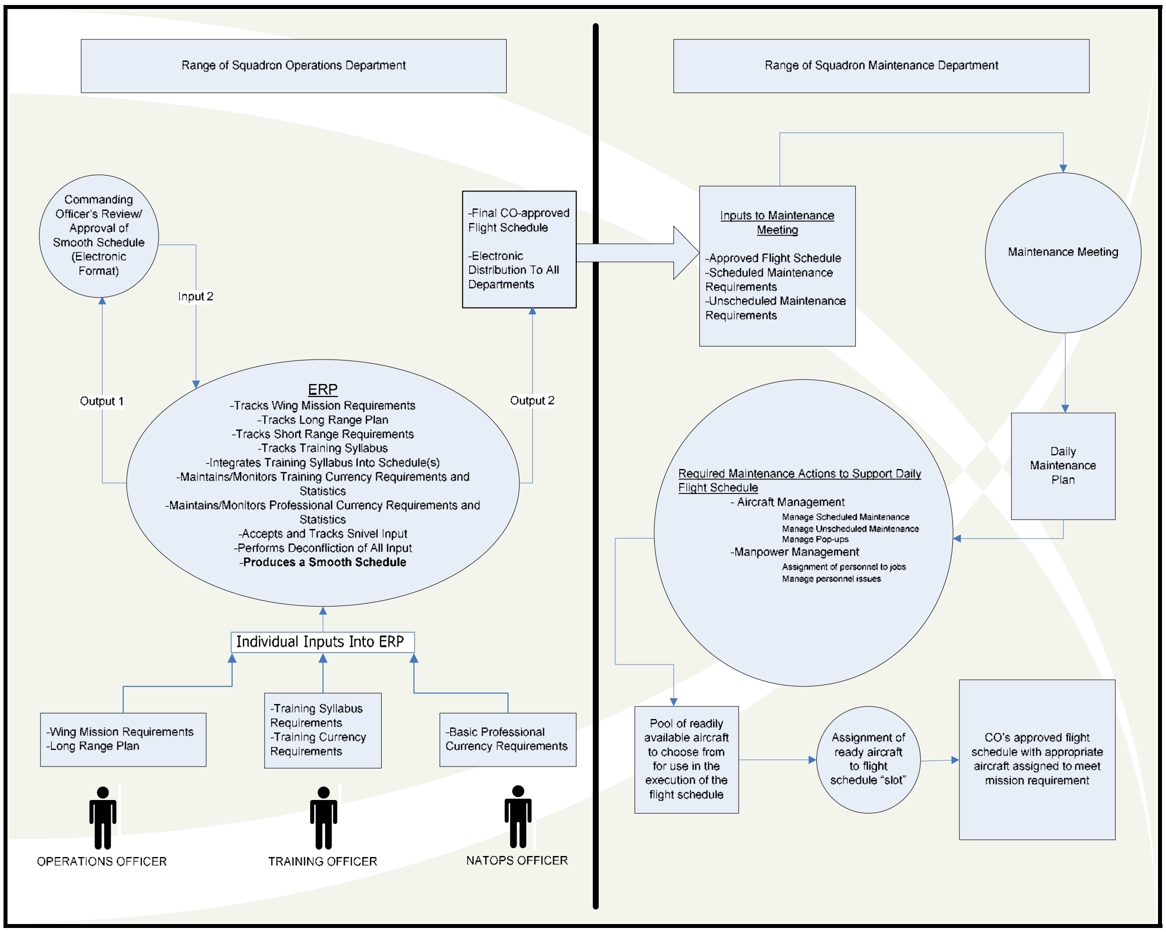

Figure 17. Radical Flowchart

The Radical represents a vast departure from the "old" way of doing business as it allows many of the input functions that were provided by the Schedules Officer to be generated automatically when "requirement to fly" information is entered into the system by the Operations Officer and Training Officer. It further acts as a quasi Decision Support System in that it churns the input information and checks it against If-then code to provide the quality assurance viewpoint that was previously provided by the Assistant

Operations Officer. The Radical leaves the Operations Officer in place in order to assure quality information is entered into the ERP and to provide oversight of the output. The adage of garbage in/garbage out is reconciled by the oversight provided by the Operations Officer.

Previously in the "As-Is" model, the NATOPS Officer was required to manually check the schedule document against his roster of personnel qualifications to ensure that all members assigned to the schedule were safe to fly. There was no automation inside of the process model that allowed the "As-Is" schedule writing tool, SHARPS, to automatically check and then flag a violation of any safety of flight rules. The Radical model will utilize an If-then coding statement to check qualification currencies and will automatically flag any violations of the currency requirements. The NATOPS Officer is still required in the process model in order to provide the checks and balances system needed between the aviation safety requirements of the unit and the training requirements of the Training Officer.

The Commanding Officer (CO) is provided more "real time" information in the Radical than his view in the "As-Is". The CO can view the schedule as it is being developed via the ERP. The CO is able to provide input to the schedule and suggest changes at any point during the process. The ERP provided in the Radical allows the CO the ability to send the "schedule in work" back to the beginning of the process at any time. If the CO chooses to not look at the schedule until it is ready for his viewing and signature he is able to do so. The output of the Radical is the same as the "As-Is"; only the processes to produce the output have changed to become more efficient. Further, the two positions of the Assistant Operations Officer and the Schedules Officer are now available more often to fly missions in support of the unit.

The Radical, with its reduction in force required to actively produce the schedule combined with the hefty increase in % IT, returned an increase in Return on Knowledge (ROK) of 1723% as shown in Figure 18 below (KVA spreadsheet). Again, the assumption remains that the unit will accept Business Process Re-engineering that will create different processes than those currently in use as formerly depicted in the "As-Is".

"RADICAL" KVA SPREADSHEET

Ops- Radical

COG	Subprocess	LT (hours)	OJT (hours)	ALT (hours)	% IT/value of IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	Fired (per hr)	# of personnel	Annual Salary ($)	Salary per hr ($)	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Ops Officer	Input long range schedule into ERP	8	16	24	80%	120.00	0.016	0.08	0.002	1	$100,000	$48	0.24	0.01%	$0	$0	21554%
	Conduct Firing Ranges scheduling	8	8	16	80%	80.00	0.5	3	0.075	1	$100,000	$48	6	0.19%	$8	$2	460%
	Update long range schedule into ERP	0	8	8	80%	40.00	0.5	5	0.125	1	$100,000	$48	5	0.16%	$7	$3	230%
	Deconflict Schedule	0	0	0	210	210.00	0.016	5	0.125	1	$0	$0	26.25	0.82%	$36	$0	
	Generate Schedule	0	0	0	250	250.00	0.016	5	0.125	1	$0	$0	31.25	0.98%	$43	$0	
	Distribute Schedule	0	0	0	75	75.00	0.016	5	0.125	1	$0	$0	9.375	0.29%	$13	$0	
NATOPS	Update / Input pilot qualifications	8	8	16	80%	80.00	0.25	5	0.125	1	$100,000	$48	10	0.31%	$14	$2	920%
	Check Schedule for NATOPS violations	0	0	0	200	200.00	0.016	5	0.125	1	$0	$0	25	0.78%	$35	$0	
Training Officer	Input training syllabus into ERP	8	16	24	80%	120.00	0.016	0.08	0.002	1	$100,000	$48	0.24	0.01%	$0	$0	21554%
	Update training schedule into ERP	0	8	8	80%	40.00	0.5	5	0.125	1	$100,000	$48	5	0.16%	$7	$3	230%
CO	Critique/approve daily schedule	8	16	24	80%	120.00	0.25	5	0.125	1	$125,000	$60	15	0.47%	$21	$2	1104%
	Schedule Distribution	0	0	0	50	50.00	0.016	5	0.125	1	$0	$0	6.25	0.20%	$9	$0	
	TOTAL			120		1385.00	2.112						139.605	4.36%	$193	$11	1723%
													3061.64				
													3201.24429				

Assumptions
1 week = 40 hours
1 month = 4 weeks
1 year = 50 weeks = 2000 hours
Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus
There is an explicit assumption that each officer that submits the schedule, submits it without mistakes and that he is not required to go back and redo it
There is an implicit assumption that there is perfect coordination among the officers that have to do with the schedule, including the CO, and so everyone knows what is required (no need to redo it because of, i.e. CO's vision was unclear)
Yearly Revenue $9,200,000 (4000 hours / year * $ 2300 hour = revenue = $ 9200000 aquired from NETJETS - Executive Jets Management)

time conversions:

weeks	days	hours	minutes
0.0125	0.0625	0.5	30
0.01875	0.09375	0.75	45
0.05	0.25	2	120
0.1	0.5	4	240
0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440

Figure 18. Radical KVA Spreadsheet (Operations)

The elimination of the two aforementioned positions can be noted on the spread sheet as well as the increase in the percentage of IT used in the new process. The NATOPS Officer has a ROK of 920% mainly due to an increase in his IT usage to 80%. The NATOPS Officer’s job is automated in that the ERP will check the status of safety qualifications through the use of a query rather than the manual process of the “As-Is”. The arduous process of ensuring a Quality Assured (QA) schedule that was previously done by the Assistant Operations Officer, and the Operations Officer, is now being handled through the code of the ERP. The QA process, previously a manual process but requiring a great deal of on-the-job (OJT) learning time, is now eliminated and thus the Return on Knowledge increase and a financial outlay decrease are realized.

The ROK from the “As-Is” was previously noted at 526% and the radical moved it to 1723%. The ROK, through the use of more IT and allowing the ERP to shoulder more of the work load, effectively increased the ROK more than three times greater than before. The “To-Be” spreadsheet had an ROK output of 669%. The radical again provided a modest increase of nearly triple the value of the Return on Knowledge by utilizing the ERP to produce the same output of a signed and quality assured flight schedule. The To-Be model provided an additional financial savings with the elimination of one position. The Radical improved upon the financial savings even more by eliminating two positions and allowing the ERP to conduct those same processes that the eliminated workforce once DoD.

With regard to the radical approach to process reengineering within the Maintenance Department we discovered that no actors could feasibly be eliminated, as viewed in the Radical Maintenance Flowchart depicted below in Figure 19. Unlike the Operations Department that depended heavily upon schedule de-confliction, the Maintenance Department operates at a level where manual processes are more of a necessity and are hence more difficult to automate fully. However, there are countless ways to improve current practices using a radical approach.

One of the most logical areas for improvement was mentioned previously, the introduction of an automated logbook entry system. Although Maintenance Control personnel (logbook clerks) would not theoretically be able to be omitted fully with the introduction of such a system accumulating cost savings on par with the OPS Radical, there are a myriad of benefits to be realized.

One obvious benefit is in the increased reliability in reporting for reasons previously mentioned before. Utilization of this type of technology allows for faster more accurate processing of entries taken from the individual work-centers, maintenance control, and the aircraft itself. Since these actors are currently performing the previously mentioned processes manually, the implementation of new business processes would allow them to simply have to monitor these new processes, thereby leaving more time to concentrate on the multitude of other processes within their realm of responsibility. Additionally, the level of training that is required has diminished along with the requirement for knowledge of the logbook keeping process, which in turn, means decreased overall costs associated with providing time to perform the required OJT.

RADICAL PROCESS FLOWCHART (MAINTENANCE)

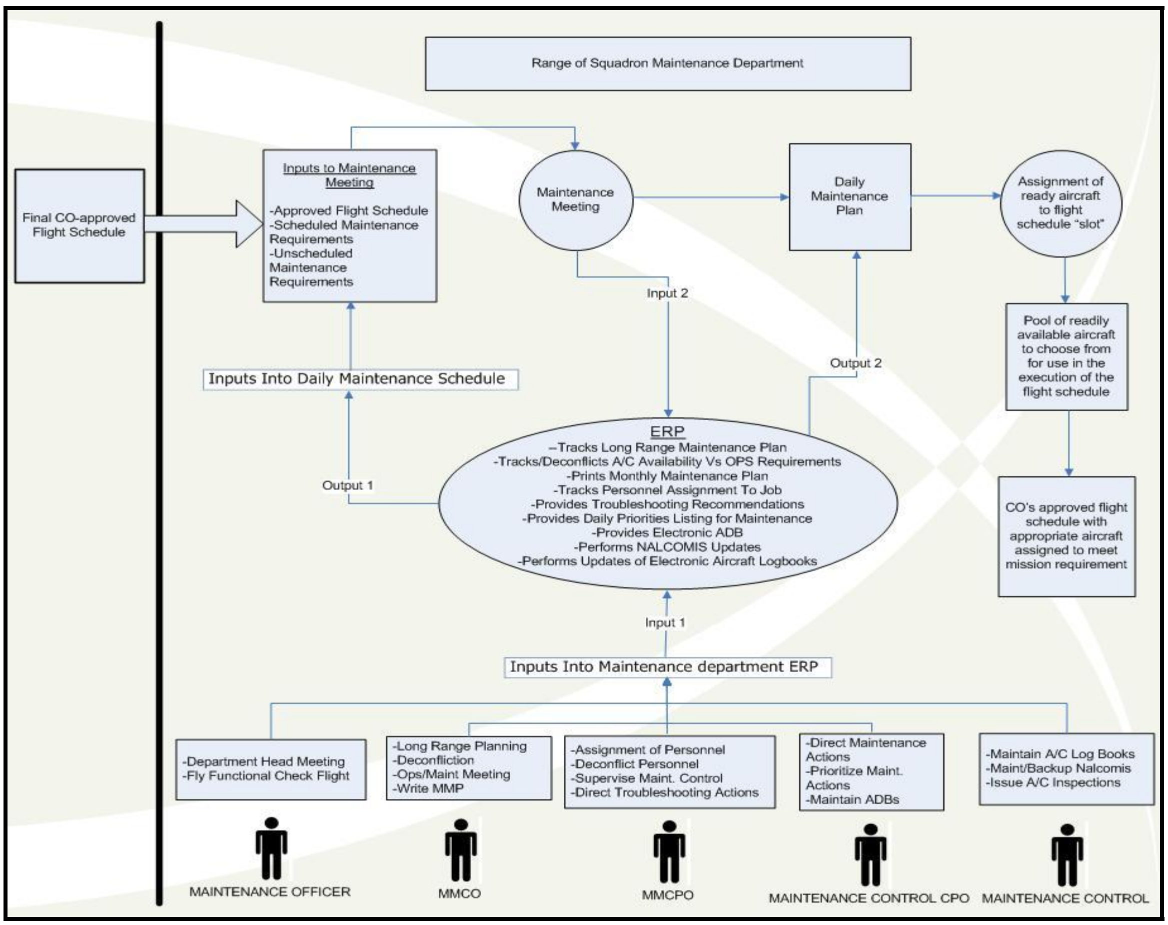

Figure 19. Radical Flowchart (Maintenance)

The radical approach to the Maintenance Department's execution of the daily flight schedule represents the possibility that the introduction of an ERP solution into the organization would likely provide for more timely and accurate decisions on an overall basis. Although it is an unknown of the ERPs ability to successfully replace the benefit achieved by human interaction on these processes within the organization; the ERPs value in a supporting role to everyday decision-making is apparent. During the execution of such tasks as tracking maintenance long-term goals, providing de-confliction of available aircraft against OPS requirements, or setting daily maintenance priorities based upon established minimums, the real benefits of an ERP as a decision aid is also apparent. The result of our assumptions regarding the possible benefits associated with the introduction of an increased level of IT within the Maintenance Department is displayed in the Radical KVA Maintenance spreadsheet, Figure 20.

“RADICAL” KVA SPREADSHEET (MAINTENANCE)

Maint- Radical

COG	Subprocess	Rank Order	Nominal Time (NT)	LT (hours)	OJT (hours)	ALT (hours)	% IT/Value of IT	TLT (hours)	Time to Complete (hours)	Times fired (per week)	Fired (per hr)	# of persons	Annual Salary ($)	Salary per hr($)	TLT x # fired x # of persons	Allocation Factor (%)	Numerator	Denominator	ROK % (Revenue / Expense)
Maintenance O	Weekly OPS/MO/CO Maint Meeting	17	2	0	3	3	50%	6.00	0.5	1	0.025	1	$100,000	$48	0.15	0.00%	$0	$1	34%
	Flys FCFs to increase A/C availability	11	3	0	5	5	60%	12.50	0.5	2	0.05	1	$100,000	$48	0.63	0.02%	$1	$1	72%
MMCO	Long Range planning for Maint Actions	6	6	8	15	23	75	98.00	0.016	5	0.125	1	$0	$0	12.25	0.38%	$17	$0	
	Deconflicts A/C avail vs Ops Flt Reqs	4	4	0	20	20	100	120.00	0.016	25	0.625	1	$0	$0	75.00	2.34%	$104	$0	
	Approves permission to fly and aircraft limitations	5	4	0	20	20	70%	66.67	0.25	12	0.3	1	$80,000	$38	20.00	0.62%	$28	$3	958%
	Supervises Maint activities	3	8	8	36	44	50%	88.00	1	12	0.3	1	$80,000	$38	26.40	0.82%	$36	$12	316%
Maintenance Master Chief	Assigns Workcenter Personnel	7	7	4	8	12	80%	60.00	0.25	12	0.3	1	$78,000	$38	18.00	0.56%	$25	$3	884%
	Deconflicts Personnel TAD Requirements	14	3	0	2	2	50%	4.00	0.5	5	0.125	1	$78,000	$38	0.50	0.02%	$1	$2	29%
	Supervises Maint activities	2	12	16	24	40	50%	80.00	0.5	20	0.5	1	$78,000	$38	40.00	1.25%	$55	$9	590%
	Order specialist flight technicians to support Flt Sched	12	4	0	4	4	30%	5.71	0.25	12	0.3	1	$78,000	$38	1.71	0.05%	$2	$3	84%
	Directs Troubleshooting Maint Actions	8	9	4	24	28	20%	35.00	0.25	24	0.6	1	$78,000	$38	21.00	0.66%	$29	$6	516%
Maintenance Control CPO	Directs Maint Actions to support Flt Sched	1	14	4	60	64	80%	320.00	0.05	133	3.325	2	$60,000	$29	2128.00	66.47%	$2,940	$10	30655%
	Prioritizes Workcenters efforts (ea shift)	9	6	0	10	10	60%	25.00	0.25	12	0.3	2	$60,000	$29	15.00	0.47%	$21	$4	479%
	Monitor A/C status, availability and serviceability	10	6	4	4	8	80%	40.00	0.05	20	0.5	2	$60,000	$29	40.00	1.25%	$55	$1	3832%
Maintenance Control	Maintenance and upkeep of IT systems	13	8	8	16	24	80%	120.00	0.5	20	0.5	1	$32,000	$15	60.00	1.87%	$83	$4	2155%
	Issue A/C & GSE inspections to workcenters	15	4	4	8	12	60%	30.00	0.25	4	0.1	1	$32,000	$15	3.00	0.09%	$4	$0	1078%
	Maintain A/C Log books	16	0	0	0	0	200	200.00	0.016	120	3	1	$0	$0	600.00	18.74%	$829	$0	
	TOTAL		100			319		1310.88	5.148		10.975				3061.64	95.64%	$4,230	$59	7196%
	Correlation factor (NT-ALT)	0.879066													139.605				
															3201.24				

Assumptions
1 week = 40 hours
1 month = 4 weeks
1 year = 50 weeks = 2000 hours
Training Officer is a graduate of Top Gun School (10 weeks), but only 1 week of that LT is producing knowledge for planning the proficiency training syllabus. .
CO attends a formal course that lasts 8 weeks but only 3 days (0.6 weeks) out of this 8 week LT are used to learn how to examine, review and critique the daily schedule
There is an explicit assumption that each officer that submits the schedule, submits it without mistakes and that he is not required to go back and redo it
There is an implicit assumption that there is perfect coordination among the officers that have to do with the schedule, including the CO, and so everyone knows what is required (no need to redo it because of, i.e. CO's vision was unclear)
Yearly Revenue $9,200,000 (4000 hours / year * $ 2300 hour = revenue = $ 9200000 aquired from NETJETS - Executive Jets Management)

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0.05	0.25	2	120
0.1	0.5	4	240
0.2	1	8	480
0.4	2	16	960
0.5	2.5	20	1200
0.6	3	24	1440

Figure 20. Radical KVA Spreadsheet (Maintenance)

The introduction of increased levels of IT into the Maintenance Department areas mentioned in the previous section show high levels of ROK across the entire organization. For the sub-process of directing maintenance actions to support the flight schedule, performed by the Maintenance Control CPO, a percentage increase in IT of just 50% gave us a two-fold return on knowledge. Additionally, this increase in ROK was successfully achieved with a very conservative, 20 percent combined reduction in learning time (LT) and OJT.

Assuming that one could decrease the amount of formal learning time even further, the perceived benefit of an investment in IT becomes even greater. In the Radical, the addition of the value of IT in the sub-processes of long range planning for maintenance actions, de-conflicting aircraft availability, and maintaining aircraft logbooks allowed for overall increases in the number of cycles performed and an overall reduction in time to complete, doing so with no added expenses.

In our "To-Be" assumptions, the logbook clerks are able to complete, on average, 90 logbook entries in a one week period of time. With the introduction of IT, according to our estimates the IT solution would provide a minimum of a 30 % increase in the amount of logbook entries that are able to be performed with all of the obvious benefits that have been previously mentioned.

C. SUPER RADICAL

The group further looked at how much more efficiency could possibly be obtained if the Information Technology envelope was pushed even further and a full automation of the squadron scheduling process was attempted. Figure 21 below, represents such a "Super Radical" model with full automation.

In the super radical process model, all pilots except for the CO are free from the task of producing a schedule and therefore able to fly more missions and increase their and the squadron's combat readiness proficiency. The freeing up of war fighters to hone their core capabilities is the goal of DoD and is in line with the corporate business model when considering whether to outsource tasks that are not core capabilities. In the super radical, the ERP is supported by Business Intelligence (BI). Normally ERPs are very good at transactional processes but rarely do they provide a means of tactical or strategic decision making. By incorporating BI into the ERP and allowing adjacent and upper units access to the system, managers have more access to decision making tools.

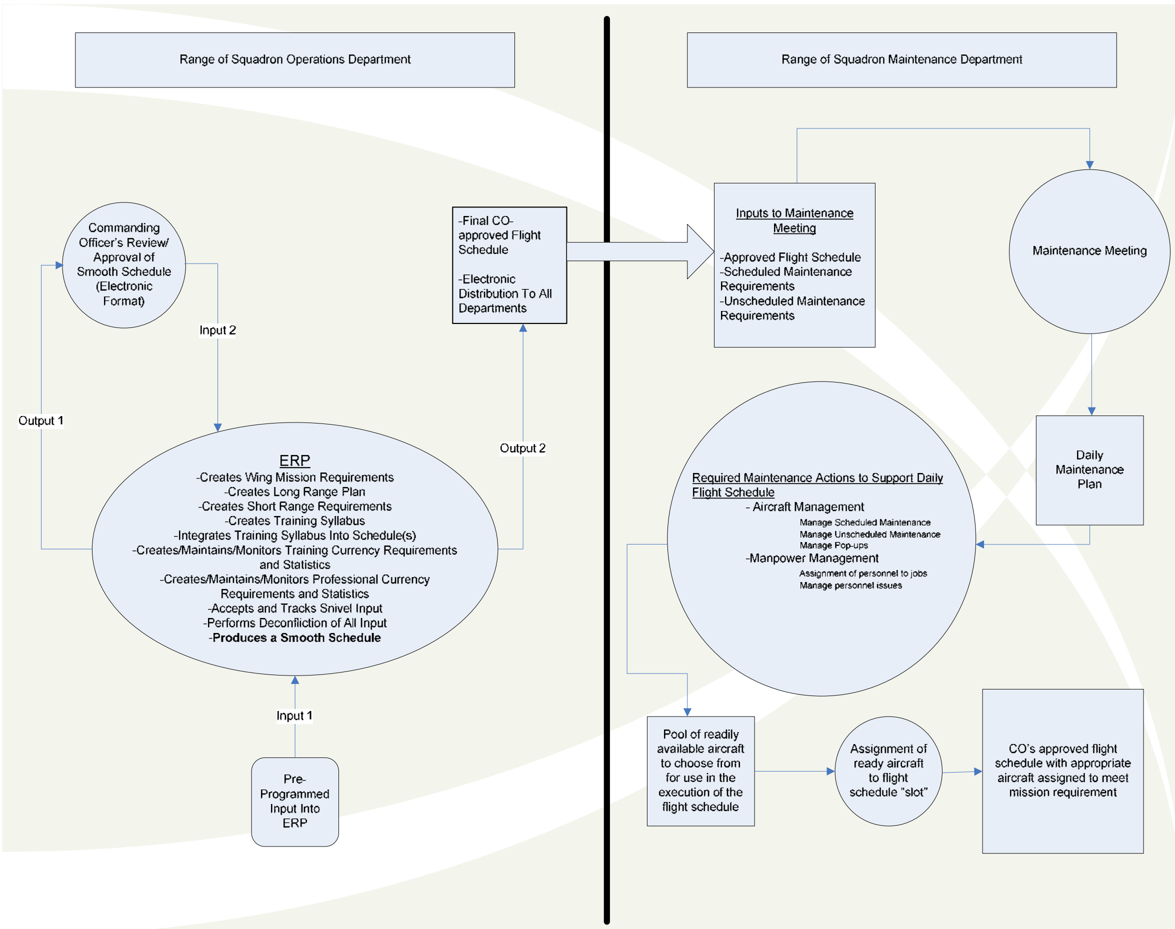


Figure 21. Super Radical Flowchart

Managers of the entire process of producing flight requirements down to the individual flyers and maintainers will have real time access to any tasks that are pending or currently being flown. This "all access" to data via the data warehouse will allow the managers to create any type of spreadsheet or form required in order to develop strategic decision making. For example, if a manager wanted to know which aircraft was the most dependable according to the maintenance records of availability, the information could be readily processed. If the manager wanted to know which pilot had the most current qualifications and the most experience, this information could also be extrapolated from the database. If this database were culminated into one form, one could see very easily how crews and aircraft could be chosen together in an attempt to assure mission success. This strategic and tactical decision making ability could prove to be invaluable in support of high visibility and/or critical missions.

The super radical is connected to a data warehouse in accordance to the basic business model provided by BI. The data warehouse contains not only all info about the personnel and materials in the squadron but also it contains information regarding supply and maintenance support. The super radical ERP is able to produce daily schedules based upon the availability of parts, personnel, and the requirements to train. The Operations Officer’s prior job of tracking and producing long range plans is now self- generated by the system. The system will utilize statistics and requirements in order to decide which training missions need to be flown in order to maintain and increase the readiness proficiency of the squadron.

The Training Officer’s requirements will be automatically tracked by the new ERP by managing the squadrons personnel by using a percentage of combat readiness proficiency required for any given deployment or garrison schedule. By viewing the readiness proficiency as a percentage, pilots who are lower than a set percentage will have priority to fly along with those pilots designated as higher priority such as Instructors. In the Super Radical all requirements of upper level units such as the Air Wing are input into the ERP via real time inputs. The ERP will then validate the input and attempt to provide a schedule that will meet the demands of the input. The ERP will use the data warehouse for these validations by checking availability of all personnel, aircraft, and all safety of flight items such as bouncing the requirement off of the previous schedule to ensure that no pilot is double scheduled or breaking crew rest.

The oversight of the system will be provided for at the squadron level by the Commanding Officer. Each day as the schedule is produced by the ERP, it is then made available to the Commanding Officer for viewing and approval. After viewing the schedule and approving it, the Commanding Officer is able to digitally sign the document and it is automatically distributed to all parties and available for printing.

The Super Radical for our project ends at the Operations Department but it is easy to see how this system could also automate the assignment of aircraft to the schedule in the Maintenance Department.

The following Figure 22 depicts all of the models mentioned heretofore and allows a depiction of the results of all of the models created in an easy to read, side by side, format.

COMPARATIVE ASSESSMENT OF MODELS

Function	Allocated Knowledge	Allocated Percent	Numerator	Denominator	ROK
AS-IS Ops	63.85	4.03%	$ 178.14	$ 33.85	526%
AS-IS Maintenance	1521.39	95.97%	$ 4,244.93	$ 94.92	4472%
	1585.24	100.00%	$ 4,423.08	$ 128.77	3435%
To-Be Ops	86.78	4.17%	$ 184.49	$ 27.57	669%
To-Be Maintenance	1993.66	95.83%	$ 4,238.59	$ 81.48	5202%
	2080.44	100.00%	$ 4,423.08	$ 109.05	4056%
Radical Ops	139.61	4.36%	$ 192.89	$ 11.20	1723%
Radical Maintenance	3061.64	95.64%	$ 4,230.19	$ 58.79	7196%
	3201.24	100.00%	$ 4,423.08	$ 69.98	6320%

Figure 22. Comparison of Models

D. EXAMPLE USE OF THE XVIONICS ERP TOOL

This section will provide example views of the Xvionics XV-OMS 3.0 ERP tool. This section provides the reader with examples of the various views that can be made accessible to the end user. These views are not all inclusive and are representational only. However they do provide the reader with a solid base of expectation for the program provided by the Xvionics Corporation. It is relatively easy for one to surmise the benefit of such a system that allows any user with the correct permissions to gain access to any required information at “real time” speeds. This attribute will allow a tactical aviation squadron to increase their sortie rate by eliminating redundant processes and reducing the time required for others. The reduced administrative time could very lead to an increase in core competencies as the previously spent time can better utilized to allow pilots to fly and maintainers to actually turn wrenches.

The flight mission order view, Figure 23, is what the officer making the schedule would use when generating a requirement for a mission. In this view, all pertinent data relating to a mission is either input into the system or selected by means of drop-down box. Information included in this view include the mission type, call sign, number of aircraft, type of aircraft, as well as many other types of information.

Once completed by the scheduling officer, the mission requires approval by higher authority, with this being accomplished by a system of permissions. Once the designated authority has approved the mission, the mission becomes part of the Schedule View. One of the advantages to the use of a form like this is that it greatly reduces the amount of time required to generate a schedule, along with the benefit of greater accuracy with relation to the input of mission codes into the system.

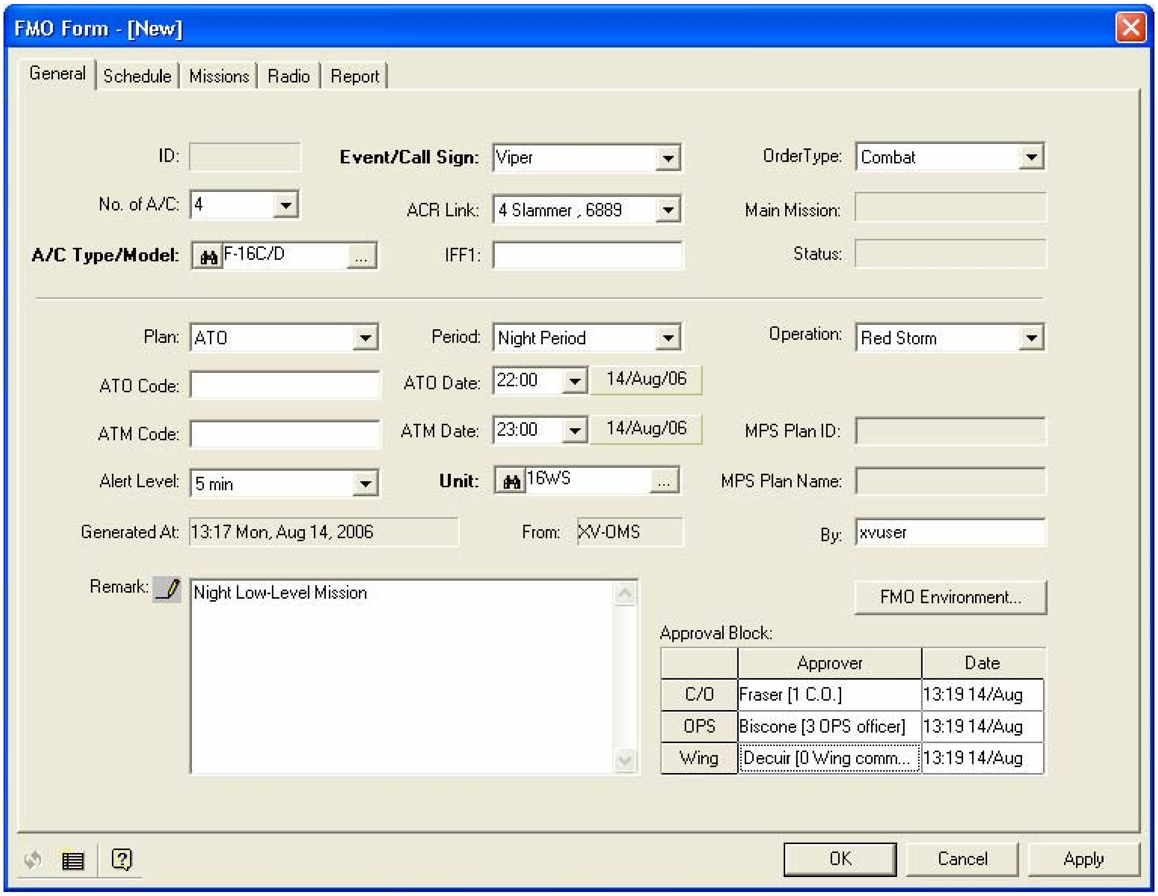


Figure 23. Flight Mission Order Initiation View

The flight schedule viewing module in Xvionics OMS (XV-OMS), Figure 24, has the capability of displaying every type of mission order, except Technical Mission Orders (TEMOs). The four mission orders that the schedule view supports are the Flight Mission Order (FMO), Flight Support Order (FSO), Training Mission Order (TMO), Ground Mission Order and (GRMO).

The use of XV-OMS allows for the filtering and sorting of all types of mission order data. The software only displays planned or active orders, and when the orders have already been executed, they are deleted from the scheduling window after a predetermined amount of time. Each section of this view lists the pilots, aircraft, call-signs, mission type, take off and landing times as well as several other categories of data.

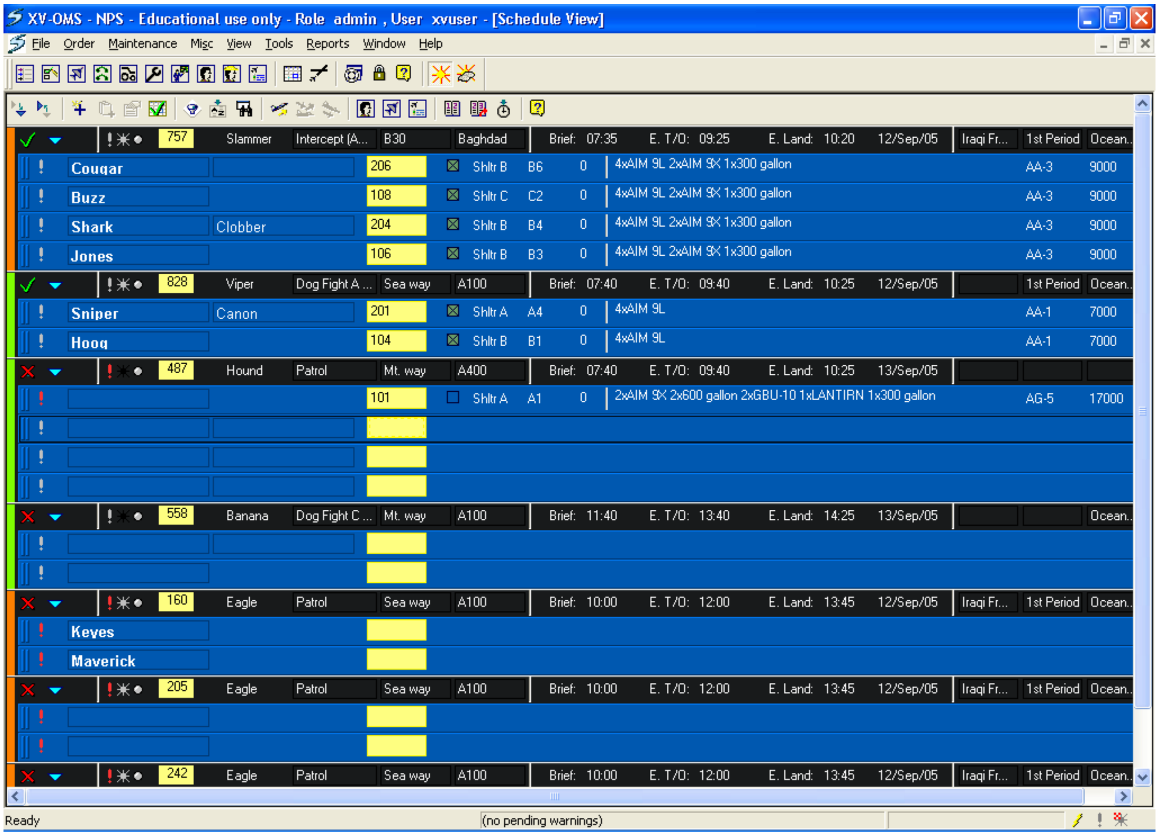


Figure 24. Flight Schedule View

The information located on this screen, as well as the information listed on the following screens, is available only to those personnel with the required permissions.

In debrief view, Figure 25, XV-OMS provides the aircrew with an electronic means of capturing post-flight data. By clicking in any of the fields located in the above form, one is able to update the XV-OMS database with the most current information. Information that falls into this category would be such items as the actual takeoff and landing times, aircrew tasks completed during the flight, type and amount of ordnance expended, or any number of other categories of information. Additionally, there is a capability that allows the uploading of video from aircraft on-board video systems that provide aircrew with video footage taken during the preceding flight that the aircrew uses to aid in the evaluation of the entire flight evolution.

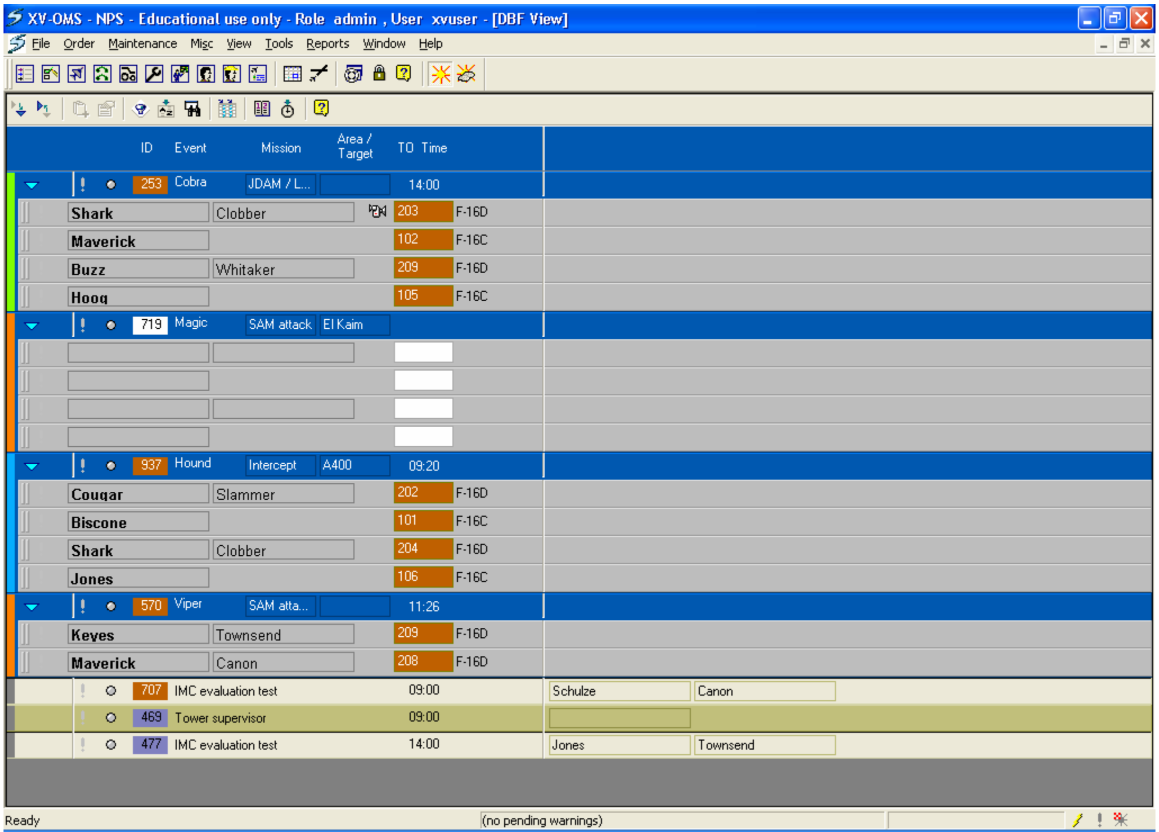


Figure 25. Debrief View

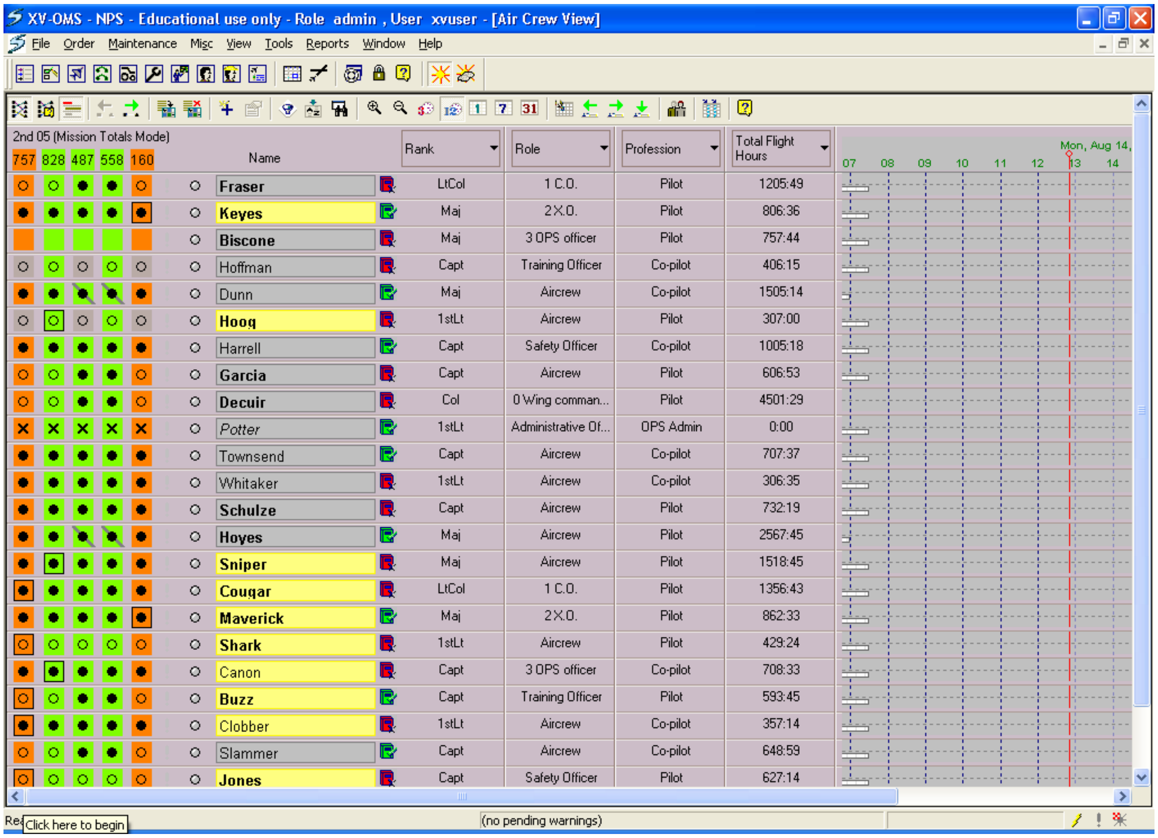
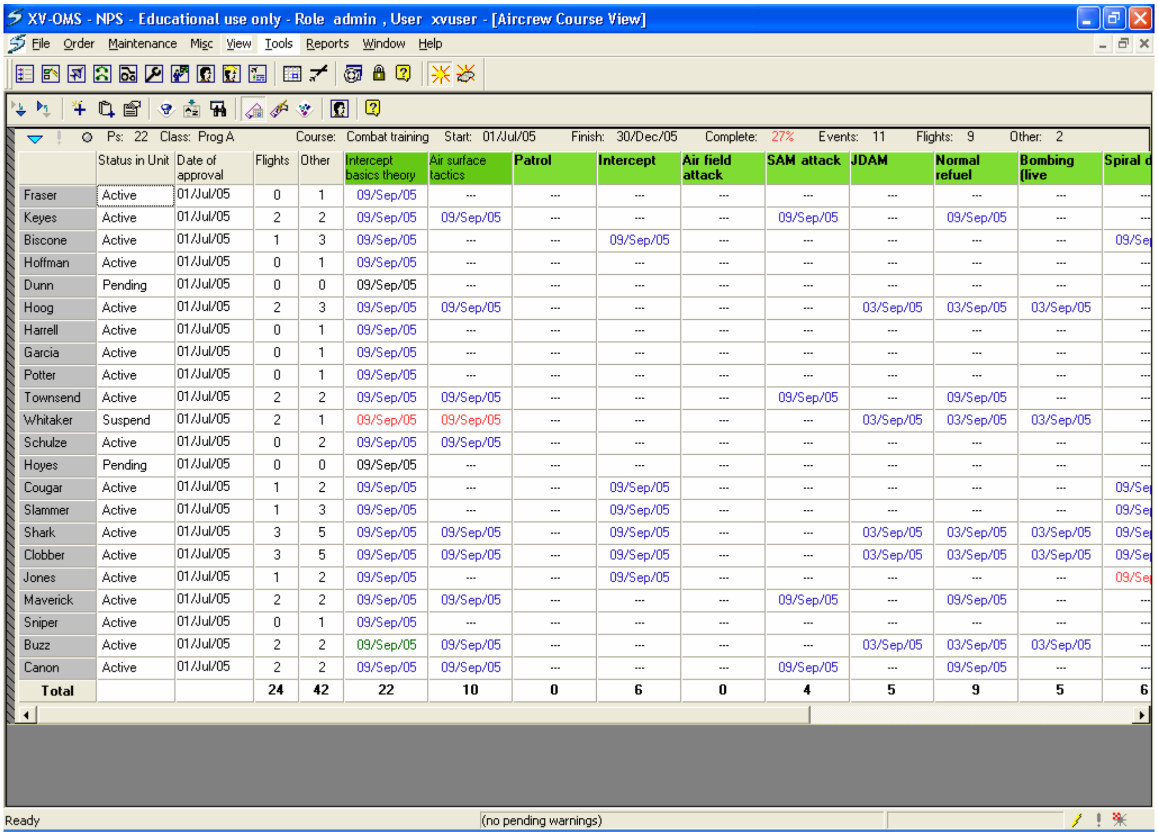


Figure 26. Aircrew View

The aircrew view, Figure 26 within the XV-OMS framework possesses the ability to manage details for aircrew and other officers within an organization. In the above figure, each row represents a single aircrew. By clicking in the requisite area, one can view any data about the aircrew that they need to in a just a matter of seconds. Some examples of the type of data available in the aircrew view are:

- Graphical representation of an aircrews qualifications as related to a particular mission
- Professional and personal details
- Qualifications and performance history
- Training and readiness levels
- Current and planned activities
- Physical presence

In addition, XV-OMS also keeps historical data for reports and monitoring.



	Status in Unit	Date of approval	Flights	Other	Intercept basics theory	Air surface tactics	Patrol	Intercept	Air field attack	SAM attack	JDAM	Normal refuel	Bombing (live	Spiral d
Fraser	Active	01/Jul/05	0	1	09/Sep/05	---	---	---	---	---	---	---	---	---
Keyes	Active	01/Jul/05	2	2	09/Sep/05	09/Sep/05	---	---	---	09/Sep/05	---	09/Sep/05	---	---
Biscone	Active	01/Jul/05	1	3	09/Sep/05	---	---	09/Sep/05	---	---	---	---	---	09/Se
Hoffman	Active	01/Jul/05	0	1	09/Sep/05	---	---	---	---	---	---	---	---	---
Dunn	Pending	01/Jul/05	0	0	09/Sep/05	---	---	---	---	---	---	---	---	---
Hoog	Active	01/Jul/05	2	3	09/Sep/05	09/Sep/05	---	---	---	---	03/Sep/05	03/Sep/05	03/Sep/05	---
Harrell	Active	01/Jul/05	0	1	09/Sep/05	---	---	---	---	---	---	---	---	---
Garcia	Active	01/Jul/05	0	1	09/Sep/05	---	---	---	---	---	---	---	---	---
Potter	Active	01/Jul/05	0	1	09/Sep/05	---	---	---	---	---	---	---	---	---
Townsend	Active	01/Jul/05	2	2	09/Sep/05	09/Sep/05	---	---	---	09/Sep/05	---	09/Sep/05	---	---
Whitaker	Suspend	01/Jul/05	2	1	09/Sep/05	09/Sep/05	---	---	---	---	03/Sep/05	03/Sep/05	03/Sep/05	---
Schulze	Active	01/Jul/05	0	2	09/Sep/05	09/Sep/05	---	---	---	---	---	---	---	---
Hoyes	Pending	01/Jul/05	0	0	09/Sep/05	---	---	---	---	---	---	---	---	---
Cougar	Active	01/Jul/05	1	2	09/Sep/05	---	---	09/Sep/05	---	---	---	---	---	09/Se
Slammer	Active	01/Jul/05	1	3	09/Sep/05	---	---	09/Sep/05	---	---	---	---	---	09/Se
Shark	Active	01/Jul/05	3	5	09/Sep/05	09/Sep/05	---	09/Sep/05	---	---	03/Sep/05	03/Sep/05	03/Sep/05	09/Se
Clobber	Active	01/Jul/05	3	5	09/Sep/05	09/Sep/05	---	09/Sep/05	---	---	03/Sep/05	03/Sep/05	03/Sep/05	09/Se
Jones	Active	01/Jul/05	1	2	09/Sep/05	---	---	09/Sep/05	---	---	---	---	---	09/Se
Maverick	Active	01/Jul/05	2	2	09/Sep/05	09/Sep/05	---	---	---	09/Sep/05	---	09/Sep/05	---	---
Sniper	Active	01/Jul/05	0	1	09/Sep/05	---	---	---	---	---	---	---	---	---
Buzz	Active	01/Jul/05	2	2	09/Sep/05	09/Sep/05	---	---	---	---	03/Sep/05	03/Sep/05	03/Sep/05	---
Canon	Active	01/Jul/05	2	2	09/Sep/05	09/Sep/05	---	---	---	09/Sep/05	---	09/Sep/05	---	---
Total			**24**	**42**	**22**	**10**	**0**	**6**	**0**	**4**	**5**	**9**	**5**	**6**

Figure 27. Aircrew Courses Summary View

This view, Aircrew Courses Summary View, Figure 27, provides a location for inputting and monitoring various qualifications associated with the flying of aircraft. These qualifications are mandatory to the success of a squadron achieving its status of being ready to deploy, in addition to many of them being safety related items. A comprehensive course listing coupled with the date that an aircrew member achieved the qualification or completed the course provides the operations or training officer with an easy to understand picture of the status of the aircrew under his cognizance. In addition to the individual qualifications, squadron totals and an overall status relating to "percent complete" is dynamically calculated.

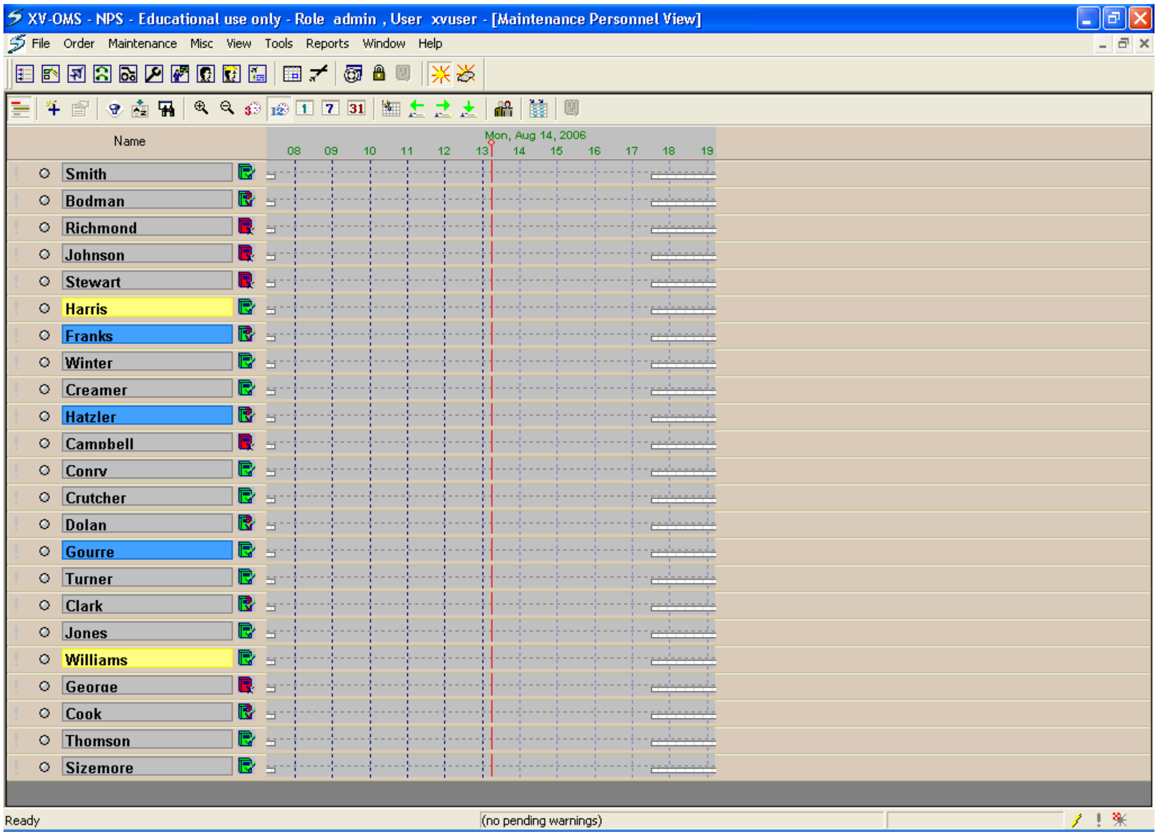


Figure 28. Maintenance Personnel View

The Maintenance Personnel View allows for the viewing of a maintenance personnel's data in a quick and easy format. With this view, one is able to monitor each of the personnel's activities, whether they are current or planned into the future. This data is depicted in Gantt chart format and allows the flexibility of being able to manage the maintenance personnel's presence within the work structure as well as being able to make inputs, updates and reviews. All of this culminates with an increased ability to allocate maintenance personnel to maintenance tasks more quickly and efficiently.

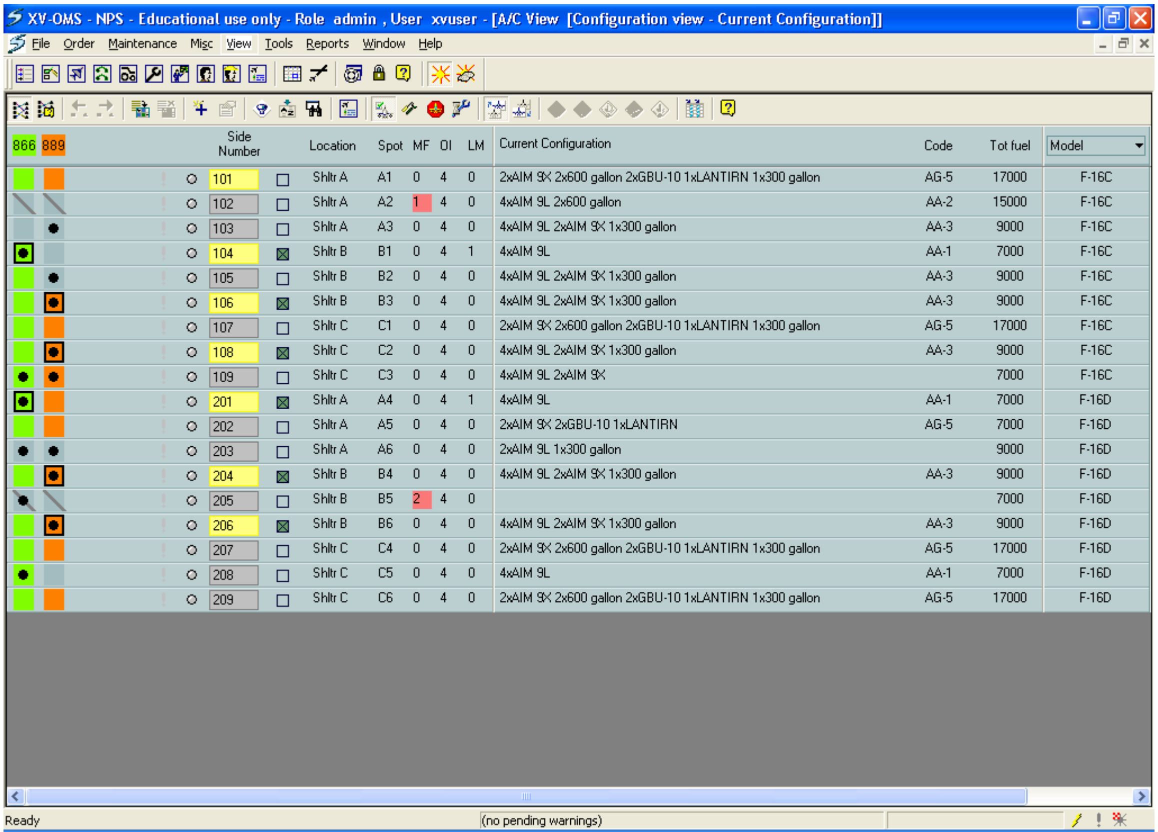
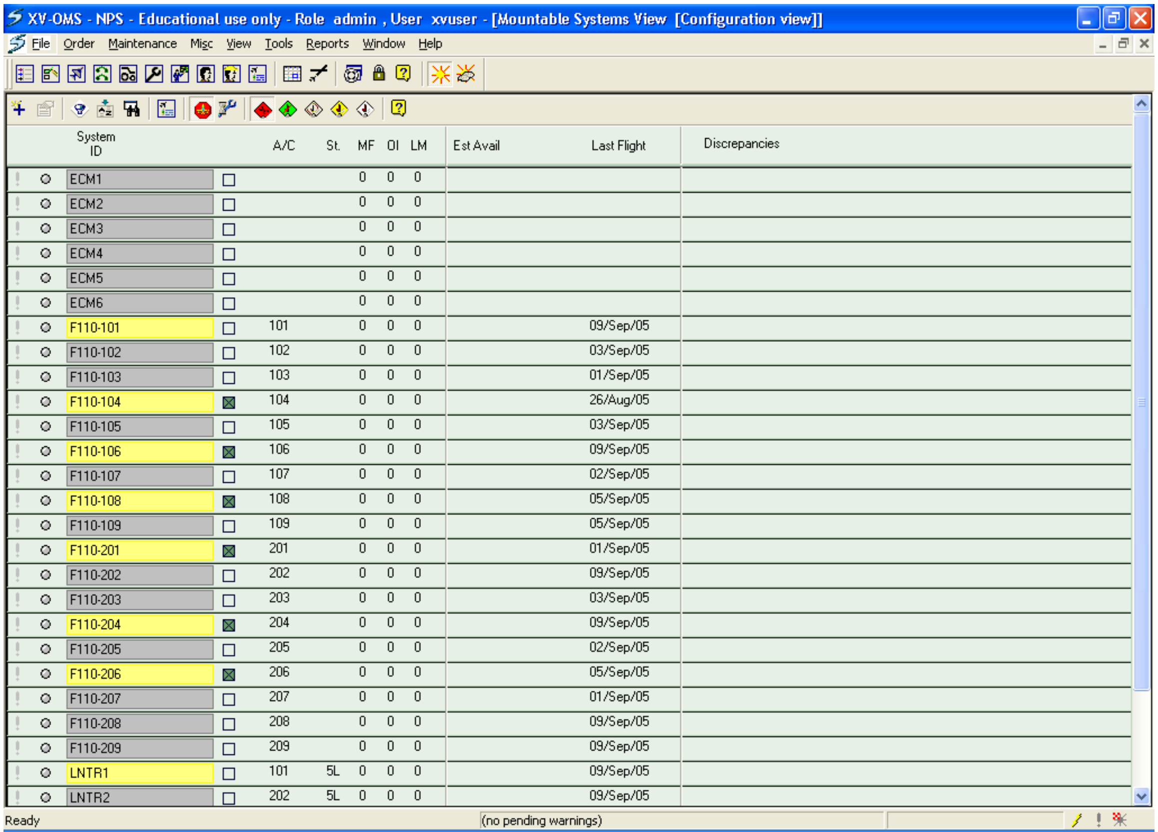


Figure 29. Aircraft View

The Aircraft View consists of a fixed data section and several dynamic data sections. The fixed section does not change in relation to the dynamic options and contains information such as the aircraft number, a symbol denoting the status of the of the aircraft in relation to its upcoming flight, the aircraft's physical location, and the number of maintenance discrepancies on the aircraft- with numbers greater than zero appearing in red notation.

The dynamic section contains four different views related to the aircraft; they are the configuration view, the installations view, the maintenance records view and the special maintenance view. The configurations view shows the aircraft's current configuration and the required configuration for any given mission allowing for quick recognition by maintenance personnel of the differences between the two configurations. The installations view provides real-time information on aircraft installed components such as and their individual statuses. The maintenance and special maintenance views provide all of the current maintenance information as related to each of the aircraft.


XV-OMS - NPS - Educational use only - Role admin , User xvuser - [Mountable Systems View [Configuration view]]

File Order Maintenance Misc View Tools Reports Window Help

System ID	A/C	St.	MF	OI	LM	Est Avail	Last Flight	Discrepancies
ECM1			0	0	0			
ECM2			0	0	0			
ECM3			0	0	0			
ECM4			0	0	0			
ECM5			0	0	0			
ECM6			0	0	0			
F110-101	101		0	0	0		09/Sep/05	
F110-102	102		0	0	0		03/Sep/05	
F110-103	103		0	0	0		01/Sep/05	
F110-104	104		0	0	0		26/Aug/05	
F110-105	105		0	0	0		03/Sep/05	
F110-106	106		0	0	0		09/Sep/05	
F110-107	107		0	0	0		02/Sep/05	
F110-108	108		0	0	0		05/Sep/05	
F110-109	109		0	0	0		05/Sep/05	
F110-201	201		0	0	0		01/Sep/05	
F110-202	202		0	0	0		09/Sep/05	
F110-203	203		0	0	0		03/Sep/05	
F110-204	204		0	0	0		09/Sep/05	
F110-205	205		0	0	0		02/Sep/05	
F110-206	206		0	0	0		05/Sep/05	
F110-207	207		0	0	0		01/Sep/05	
F110-208	208		0	0	0		09/Sep/05	
F110-209	209		0	0	0		09/Sep/05	
LNTR1	101	5L	0	0	0		09/Sep/05	
LNTR2	202	5L	0	0	0		09/Sep/05	

Ready (no pending warnings)

Figure 30. Aircraft-Mountable Systems View

The Aircraft-Mountable Systems View, similar to the aircraft view, displays all of the information regarding such aircraft mounted systems as engines, electronic countermeasures pods, and camera pods. Each aircraft-mounted item is identified with a unique identification number as well as the aircraft tail number for which it is assigned to. Status boxes are also included that correspond to the items maintenance status, stating if the mounted system is in either an “up” or “down” operational status. If the item is in a down status, then a date of estimated availability may also be provided as well.

Additionally, other information such as the last flight and a current list of discrepancies are readily available for maintenance personnel to take into consideration when making decisions.

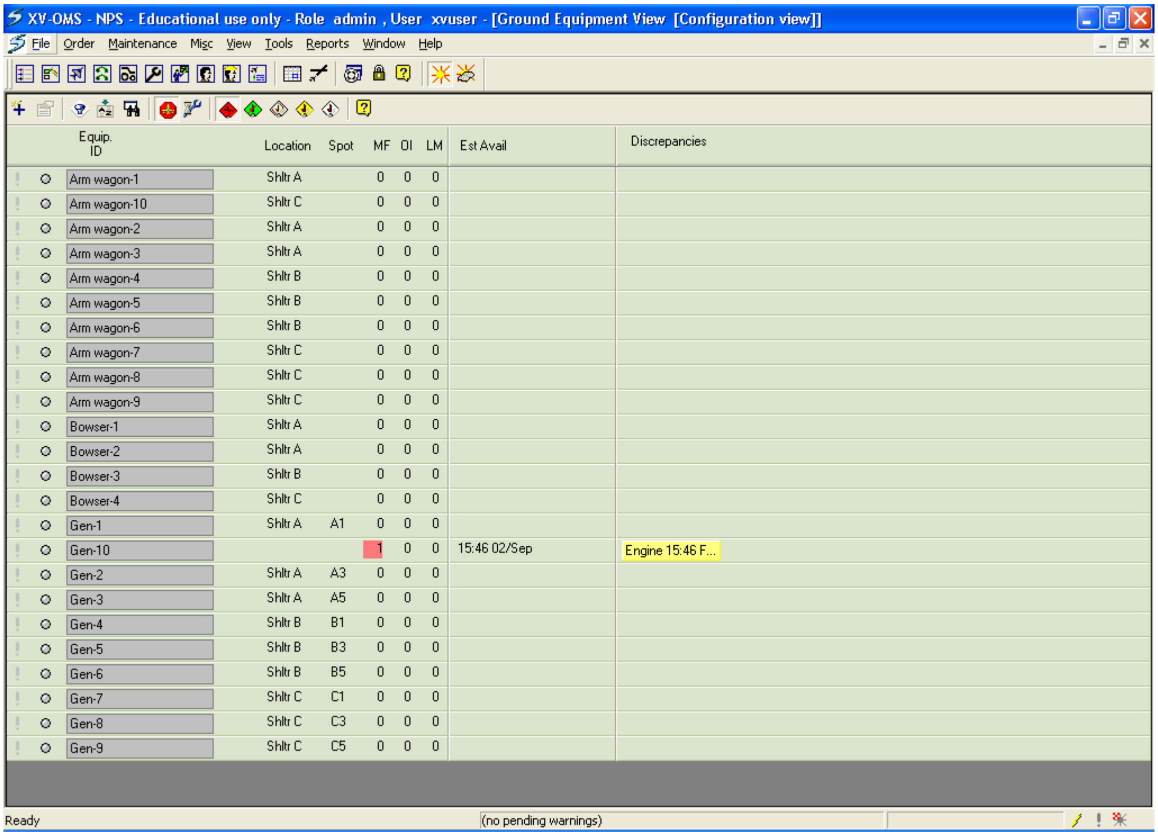


Figure 31. Ground Equipment View

The Ground Equipment View contains essentially the same information as the mountable systems view does. Ground equipment is utilized when working on the aircraft and when performing such tasks as moving the aircraft from one location to another. Examples of such equipment include ground equipment include aircraft towing vehicles, portable aircraft generators and aircraft oiling fixtures. The proper maintenance of ground equipment is essential in making sure that it is available when it is needed; this framework provides the maintainer with an easy to use screen in which to derive and input information for these purposes.

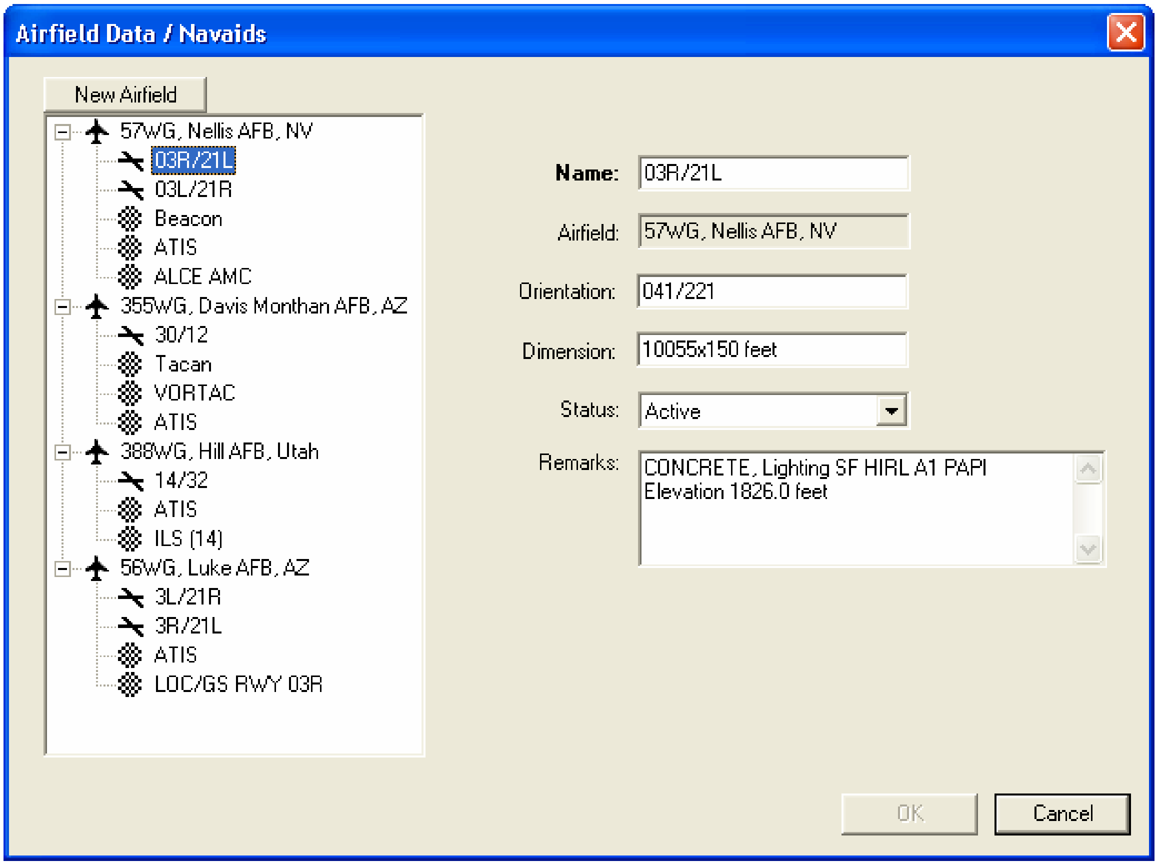


Figure 32. Airfield/ Navaid Data

The Airfield/Navaid Data View is able to be accessed by aircrew when planning a mission route. It provides airfield data such as runway numbers, dimensions, status and other pertinent remarks.

E. UTILIZING COMMERCIAL OFF THE SHELF (COTS)

An evaluation of the Xvionics software or any other Enterprise Resource Planning tool would not be complete without a discussion regarding the hurdles of using Commercial off the shelf (COTS) end items in the DoD. Since the Xvionics software is not produced by the U.S. military, it would be considered a COTS acquisition. There are many concerns that arise when the military attempts use of software or hardware that is produced by outside sources. A Project Manager or Acquisition Officer must weigh several concerns regarding security (confidentiality, integrity, and availability), maintainability, modifiability, and performance. Questions regarding these and other quality attributes will have to be specified and prioritized before enabling a commercial system to be added to a DoD component. The following section will address some of these issues along with the financial benefits of using COTS and a discussion of how the current financial system which is being transformed will support the use of COTS. Lastly, there will be recommendations for risk mitigation when implementing COTS in a U.S. defense environment.

Commercial off the shelf (COTS) products fall into the category of both hardware and software items. The low cost of purchase, as opposed to the price of development for a new system by the end user, makes COTS a great solution for enterprises that have a restrictive budget. The DoD, always in search of budget reduction methods, views the use of COTS as a viable means of meeting the IT requirements of the DoD while remaining within budget constraints placed on them by Congress.

The performance requirements that the DoD places on the COTS derives the hurdles faced by the DoD when implementing the use of commercial systems. The DoD requires that significant procedures are put in place to protect the confidentiality, integrity, and availability of all data that is transmitted, stored, and created on DoD systems. The military component of the DoD has even more stringent requirements due to the environments that the systems will be exposed to during the normal operations of a military unit. Often, and predictably, Navy squadrons will be deployed aboard ship board activities in order to train and provide combat capabilities from a sea-based platform.

It is possible to modify the source code of a COTS system, but this would require a large outlay of funds for the code, therefore eliminating the greatest advantage of COTS procurement, cost. The modified source code system is known as a Military off the shelf system (MOTS), and it can be modified by the end user or the sales vendor. The modified COTS system would not receive the same automatic updates and technical support as would the unmodified COTS system. However, the reliability of the protection of the data when using MOTS would be greatly enhanced over the use of COTS. If the modifications that the military requires are done by the vendor then MOTS will face the same hurdles as the COTS systems.[23] The government agency of the DoD will not be able to rely on the code nor updates to the code anymore than they can on an unmodified

[23] L. Sha, R .Rajkumar, and M. Gagliardi, “Evolving Dependable Real-Time Systems.” Proceedings of the 1996 IEEE Aerospace Applications Conference, vol. 1, New York, NY, 3-10 February, 1996, pp. 335-346.

COTS system. This section will discuss the financial pros and cons as seen from the viewpoints of three stakeholders; the government policy makers, the commercial vendor such as Xvionics, and the military end user.

1. Government Policy Makers

In 1994, the Defense Science Board (DSB) Task Force on Acquiring Defense Software Commercially was tasked with providing an independent advisory report to the Secretary of Defense representing their opinions and recommendations in regards to the use of COTS in the DoD. Interestingly the viewpoint of the Assistant Secretary of Defense, Command, Control, Communications and Intelligence at the time, Emmett Paige Jr., can be summarized in his quote at a software technology management conference where he stated, "U.S. war-fighters have enough to do with their missions. They don't have the time or resources to learn to use or fix software."[24]

Currently, the Secretary of Defense is highly interested in the idea of radical transformation in the DoD. Specifically, he is interested in creating an environment that will lead to an unqualified audit much in the same vein as a corporate enterprise. The Institute for Defense Analyses was contracted by the Secretary of Defense in order to support the decision making process by providing relevant, reliable, and timely information to the decision makers and managers. It is realized that partnering with the private sector can lead to performance improvement of the support systems in the DoD by leveraging the competitive nature of the corporate environment. There are many disparate systems in use throughout the DoD. During the teams' Thesis research; we witnessed many of these systems in work at various squadrons. Many systems are built and added to by individuals at the unit level and require many different interfaces in order to integrate with the systems of parallel units, upper and lower echelon units as well.

Standardization is required in order to allow the disparate legacy systems to be replaced and integrated systems to be utilized via Enterprise Resource Planning (ERP) tools and Business Process Engineering utilizing Business Intelligence (BI) mirroring the corporate arena. The use of an ERP incorporating BI will be discussed in more detail later. In order to create a standardized environment, Commercial off-the-shelf (COTS)

[24] United States Department of Defense SPEECHES, Volume 11, Number 17 "Tying Together the Best Individual Intellectual Efforts," 1998, last accessed February 2006.

systems will have to be used to the greatest extent where unique military coding is not required. The financial burden of research and development is borne by the commercial industry rather than the end users; allowing the war-fighters alluded to by Mr. Paige to concentrate on their core capability requirements.

The inherent difficulty in obtaining a clean financial audit within the DoD lies in the three different ways the DoD applies funding. The government utilizes Appropriations, Reimbursable, and Working Capital Funding; whereas, the civilian sector only uses one type of funding based on Generally Accepted Accounting Principles. Since the civilian sector deals with revenue, it is a much easier fit with COTS software. Often times, COTS software already exists for commercial applications. The DoD performs many similar functions as the commercial sector in various function levels. Market Comparables could be used in order to find the best fit/best value commercial solution to DoD system requirements. Examples would be comparing the process functions of the United Parcel Service (UPS) to an AMC squadron in the U.S. Air Force or the supply system to a corporation that has master supply chain management software such as Wal-Mart, or comparing the use of Xvionics software in a U.S. Navy jet squadron with the commercial equivalent COTS software in a commercial entity such as NetJets.

It is a fairly difficult task if not considered impossible by some, to fit the current financial framework of the DoD into a COTS system due to the many ingrained processes that makeup the three funding methods. However, if the DoD accepts Business Process Reengineering, then new processes would be adopted, standardization would be obtained, COTS could be implemented, and costs would be reduced along with the number of processes. The inefficiencies of many disparate subsystems increases the cost of use due to duplication of effort by many end users, input errors caused by multiple input environments, and loss of info due to improper interfaces between the different systems.

In roads have been made since the CFO Act was established in 1990 expressing the desire for a clean financial audit. The Defense Information Systems Agency (DISA) was established with a mission “to be the preeminent provider of information systems support to our war-fighters and others as required by the Department of Defense, under all conditions of peace and war."[25] DISA provides computer support to the DoD in all areas from accounting to medical. DISA recognizes that the rapid and ever changing environment of information technology requires commercial support. It is recognized that the "best value solution" is often reached by support from the civilian sector when making the buy or build decision. DISA is committed to ensuring the cost of supplying the computing needs of the DoD is the lowest possible while meeting the requirements of the end user, and maintaining availability to the war-fighter in any environment. The use of COTS enables this philosophy. By locating many DISA agencies throughout the U.S., the standardization hurdle is eased by the multiple sites yielding the same support to many different users.

The DoD must not only recognize the need for changes in the business process but also changes in the means of acquiring the new COTS technology. The DoD Authorization Act of 1996 contained the Information Technology Management Reform Act.[26] The reform act DoD away with the General Services Administration (GSA) Board of Contract Appeals. This allowed for implementation of large information systems and modular acquisition of said systems. This means that the development of information technology systems will be included in the cost of acquiring the system. This avenue allows the widespread use of COTS when it meets the requirements of the DoD. The use of Enterprise Resource Planning tools has become recognized as a viable means of incorporating the best value practices of the commercial sector into DoD organizations. Specific examples of these are the Navy and Marine Corps Intranet (NMCI) and the Marine Corps Enterprise Information Technology Services (MCEITS). Both will be discussed in a later section.

The Defense Science Board (DSB) found that there were many similarities between the DoD built systems and the commercial systems. However, it was noted by the task board that the commercial development efforts have "achieved better predictability and lower costs" than the DoD derived systems. It must be noted that cost is not the only factor when considering the DoD's use of COTS. The DoD must also

[25] DISA, Defense Information Systems Agency, Department of Defense, http://www.disa.mil., last accessed February 2006.

[26] United States Department of Defense SPEECHES, Volume 11, Number 17 "Tying Together the Best Individual Intellectual Efforts," 1998, website, last accessed February 2006.

consider its requirement for information assurance thus requiring a stringent oversight of commercial vendors in there development of systems to be used by the DoD. A mutual trust partnership would have to be developed and adhered to. One can easily see the applicability of this requirement when incorporating the Xvionics software program in a U.S. aviation squadron.

2. The Commercial Vendor's Prospective

The incentive is obvious for the commercial vendor. The DoD would most likely be the largest single customer to any vendor and the guarantee of payment would also be of great comfort to the vendor. Under President Bill Clinton, the telecommunications reform act was passed. It allowed for more use of telecommunications technology support from commercial sources. The need of the United States to engage in conflicts in the International arena requires a means of communicating with our international allies and coalitions. This need being met by commercial vendors leads to increased competition which in turn leads to lower costs for the DoD.

The commercial vendor is able to supply mature development processes that have been learned through many years of competition on the open market. The life cycle costs and maintenance costs are absorbed by the entire market rather than a single user when commercial vendors are used supplying a COTS system. Most military systems are proprietary in nature and have a life cycle of 20 years. The commercial software has a lifecycle of 1 to 2 years. The long lifecycle of the military system does not support quick turnarounds on upgrades, updates, and changes. The cost benefit of COTS is the life cycle support that is provided by the vendor exposing the end user to readily available updates throughout the life cycle phases.

Commercial vendors are able to supply entire systems that not only streamline the business processes but also enable many users across the organizational spectrum the ability to view real time information regarding all departments of the organization. The Xvionics ERP would allow the Commanding Officer the ability to view the schedule progress in "real time" as it is being developed by the Operations Officer. This view would allow errors to be caught early in the build process of daily schedule writing and would create greater efficiencies in the organization.

Enterprise Resource Planning (ERP) tools have been around for long time and up until now they have only been able to streamline the processes and aid in the viewing of the transactional process. However, the ERPs have not allowed the manager to be able to make strategic decisions. This capability is needed by the Military commanders and it is part of the goal of the CFO Act and the Secretary of Defense goal of providing the managers with relevant, reliable, and timely information. If we can obtain an unqualified audit, and it is utilized properly through the educated study of the output, a commander will be able to make both strategic and tactical decisions in support of the organization's mission.

The latest development in the commercial sector is the use of Business (BI) Intelligence. A recent CIO magazine poll, at the time of this writing, stated that the next big purchase in Information Technology by IT managers is going to be in the field of Business Intelligence. BI is going to allow management the ability to formulate any type of desired spreadsheet or form that they wish by pulling DoD from not only their workstation but also from DoD warehouses that can store practically infinite (as much storage as one can afford) amounts of accessible DoD. This allows the manager to be able to make decisions based on real time information and to be able to customize the DoD used to support the decision making. In environments where time is money and the competitive advantage is realized by those that have information superiority it is easy to see where the financial advantage in Business Intelligence lay. In environments where timing allows one competitor to outwit or decide faster such as in combat, BI ascertained from COTS may be the key to victory over an enemy force.

Advances in technology, increased requirements for information technology support, and the financial guidance from Congress and the Secretary of Defense have steered the DoD towards the commercial sector for more efficient, cost effective, and updated technical support. To that end the Navy and the Marine Corps have implemented programs that mirror business models of commercial industry. Navy and Marine Corps Internet (NMCI) and the Marine Corps Enterprise Information Technology Services (MCEITS) have been implemented to harvest the "best value" practices of the commercial vendor. MCEITS Enterprise IT Centers will replace the disjointed organizations that make up the current environment of DoD processing support throughout the Marine Corps. The goal of the MCEITS is to provide more consistent service, standardization, and to leverage the advancement in information technologies while increasing the protection of sensitive DoD. By making enterprise wide investment decisions, standardization and mass purchasing power will be used to achieve a greater cost benefit.

Additionally, information in the MCEITS infrastructure will be made available globally, allowing relevant, reliable, and timely information to be accessed by the decision makers. This will be enabled through the use of an enterprise enabled framework much like an Enterprise Resource Planning tool with Business intelligence. According to the government publication referenced, "MCEITS also leverages bandwidth enhancements provided by the transformational communications initiatives, such as Global Information Grid-Bandwidth Expansion (GIG-BE) and Navy-Marine Corps Internet (NMCI). Along with the IT initiatives of the Marine Corps Programs of Record such as Global Combat Support System-Marine Corps (GCSS-MC), Continuity of Operators Planning, Unit Operations Center, and Common Aviation Command and Control System to provide a managed and controlled enterprise environment from which users can access information from anywhere on the network in support of war fighting and Supporting Establishment (SE) processes.[27] Commercial vendors stand ready to provide solutions that will enable the Secretary of Defense transformational views to be realized.

3. Military End User

When incorporating COTS systems into an organization, the most cost savings will be recognized if the stakeholders are involved during the development and implementation phases. In these two phases there is no more important stakeholder than the end user. The end user is important in his/her ideas of the output of the system. The end user is the person that interfaced with the legacy system on a daily basis before the change environment. The user must have buy-in so that he/she will help with setting realistic expectations of the finished system. Since the implementation of a standardized COTS system will involve business process reengineering there must be no confusion as

[27] Government Publication Office, Warfighting Concepts, Emerging and Enabling Capabilities, Chapter 2, p. 103, GPO-017-126, 2005.

to what the output must be since the old processes required to operate the legacy system will most likely be changed for efficiency sake.

The military end user often requires a system that is physically hardened as well as information security hardened. Because of the short life cycle of COTS, security is of the greatest concern due to the prominence of patches and updates. If a modicum of security can be reached while taking advantage of the cost benefit of mass production of COTS, the goal of the Congress to find the best value while supporting the war fighter will be obtained. Often times COTS systems are rushed to market with known vulnerabilities because of the belief that he who is first to market wins. The military will have to create the aforementioned mutual trust relationships in order to establish the acceptable levels of security while still meeting the mission requirements. Fortunately, Public Key Infrastructure (PKI) is already in use in the commercial sector and its security benefits would aid the end user's requirements for secure DoD transmission.

By incorporating Business Intelligence at the unit level of management, decisions on how best to employ a unit can be made in real time in order to support the higher mission. A cost savings will be realized by eliminating redundant efforts, streamlining processes and by providing the managers with reliable, relevant, and timely information. Through the use of integration of all systems with a single interface, individual end users will be more effective in their communication with adjacent and higher units leading to faster response times furthering the cost savings.

4. COTS Conclusion

The DoD must consider a great deal of factors besides cost when considering the use of COTS, but all of those factors will have an impact on the cost. Other financial concerns are the financial constraints placed on DoD acquisitions in the form of timelines required to process requests for new projects and receive approval for funding as indicated in this chapter on COTS. The unique environments and unique requirements of DoD users require a level of sensitivity during the development, implementation, and support phases. Considerations such as the location of the building facility would have to be investigated. Fortunately, corporate espionage warrants some of the same concerns and builders of systems have had to contend with those requirements for many years and data safety is not unique to Department of Defense. Cultural bias of the DoD employees towards legacy systems will have to be overcome. A type of reward system that benefits the managers and users for financial responsibility in their decision making will lead to a greater use of COTS.

An increase in educated end users will encourage the use of the commercial best practices of implementing software. This will allow the proper support during the rapid development and change in information technology advances of the commercial sector. Security must be built into the system during development as it is very costly to try and build it into a system already in the implementation phase. An acceptance of Business Process Reengineering is required in order to accept the introduction of new technologies allowing the DoD organizations to leverage the benefits of the commercial sector. The DoD is a hierarchal based organization and thusly its members will perform to whatever standard their immediate superior demands. They will also perform to the incentive.

There has to be incentives for and decisions to reengineer the business processes of the DoD sent down from the head of the organization. There has to be a positive bias towards the use of COTS in a standardized format allowing interfaces between adjacent units and differing units such as the Air Force and the Marine Corps. The need for joint operations and interoperability requires the leveraging of commercial technology to ensure the survivability of the information superiority of the U.S. military.

F. IT OUTSOURCING FOR DOD

The research team in evaluating the Xvionics software delved into the considerations that must be discussed when deciding to outsource the IT requirements of the DoD. Our belief is that IT outsourcing, if utilized correctly, can be a smart cost-cutting initiative. If utilized incorrectly or implemented poorly; outsourcing can be very costly and an inefficient use of resources. Since outsourcing can be on any scale, a leader should plan the parameters of the scale before submitting a bid for outsourcing. If one were to need some IT help in order to get a new system online, it would be a very costly mistake to keep the temporary workers onboard far after the system has been incorporated and is in the maintenance phase. Outsourcing should only be used to enhance the capabilities that the organization does not consider to be core competencies. This allows the regular workers to concentrate on their core competencies, becoming more efficient, productive, and as a result, reducing costs to operate.

The military will outsource IT requirements in order to gain the knowledge of the outsourced agent. The core competency of the outsourced agent is their knowledge in whatever field that is being outsourced. One could argue that it is more expensive to outsource than to do it yourself, but due to the ever increasing changes in the IT environment, it is very costly to train and maintain training currency for permanent personnel handling IT issues in the military organization. Much like going out to eat at a fine dining establishment, outsourcing IT can be an expensive one time cost, but it would cost a great deal more to learn how to do all of the tasks required to serve an elaborate meal just as it would be cost prohibitive to train all military communicators to be able to handle all of the DoD IT requirements and maintain proficiency in the ever changing IT environment. Outsourcing once is much cheaper than paying for permanent personnel training continuously; of course, the outsourcing depends largely on a trusted relationship. The organization has to trust that the outsourcing agent has the correct knowledge to meet the requirement of the organization that has the outsourcing need. If the outsourced agent does not possess the prerequisite knowledge then the outsourcing will fail and will be a very costly mistake.

By utilizing outsourcing, a leader is able to take advantage of standardization amongst the enterprise. As previously stated, outsourcing can be on any scale. NMCI is an example of outsourcing on a grand scale that allows inter-enterprise standardization and allows the Navy and Marine Corps to take advantage of the absolute latest information and IT updates available. By using a business organization that has a monetary incentive, the Navy is further able to take advantage of innovative thinking that is a direct result of competition. If there was no outsourcing, as was previously the case, there is no incentive for innovation but rather personnel are motivated towards mission accomplishment only in support of the Commanders Intent. Thusly, innovative thinking due to competition, leads to efficiencies being reached that would not have been thought of otherwise in a non competitive, military IT environment. After all, the people who build systems know more about how an organization works than anyone. They have a much greater understanding of the business processes, especially efficiencies vs. effectiveness. This also provides a single source of knowledge that allows inputs for change to be more easily implemented in a much broader scope. A simple example would be Windows updates. The process would be very simple if the updates were received at a centralized location and then dispersed out from there at once to all of the supported systems. This analogy could be compared to the role of the outsourced agent and their ability to disperse their knowledge to all supported activities simultaneously.

Bottom line, if used correctly, with the proper limits on the scale parameters, outsourcing of IT allows an organization to take advantage of expert knowledge without incurring the exorbitant training costs associated with gaining the requisite IT knowledge. Outsourcing further allows the organization to take advantage of value pricing by utilizing a type of “one stop” shopping metric. Additionally, outsourcing allows the organization, through the use of a broker, to be able to place the “best” provider together with the technology need of the unit. There is no paying for frills that one doesn’t require or didn’t ask for if outsourcing is implemented correctly resulting in a greater savings. This highlights the importance of the role of the broker in that you only receive what you ask and pay for. NMCI is projected to save the Navy more than $400 million dollars per year. By eliminating the need for each unit to support itself with individual equipment (software, hardware, training, etc), outsourcing IT allows the Navy to obtain a fixed price for all of its IT needs and negotiate a performance based contract which yields the latest innovation from the business world.

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V. SUMMARY

A. THESIS DATA SUMMARIZATION

The following is a summarization of the data from the KVA with market comparables case study of VFA-14's operations and maintenance processes of producing an approved daily flight schedule for execution.

1. Allocated Knowledge

The "As-Is" models yield a total allocated knowledge of 1585.25 knowledge units (KU). This is broken down as 63.85 KU for operations and 1521.40 KU for maintenance. Allocated knowledge represents the total knowledge that resides in the processes in order for them to be executed.

The total allocated knowledge in the "To-Be" models increases 495.19 KU to 2080.44 KU from the 1585.25 KU that is resident in the "As-Is" models. This represents 86.78 KU in the operations processes and 1993.66 KU in the maintenance processes. The increases were achieved using BPR techniques to implement incremental improvements into the processes.

The total allocated knowledge in the "Radical" models increases 1120.8 KU from the "To-Be" models for a total of 3201.24 KU in the "Radical" models. This is represented by 139.61 KU for the "Radical" operations processes and 3061.64 KU for the "Radical" maintenance processes. These increases were achieved by completely redesigning the "As-Is" models into the "Radical" by using BPR techniques and using data from the Israeli Air Force "As-Is" models which have highly automated processes with the implementation of an ERP.

2. Allocated Percentages

The values of the processes in all the models in the case study are heavily weighted towards the maintenance processes. In the "As-Is", "To-Be", and "Radical" models the maintenance processes contribute approximately 95.81% of the weighted average to the total ROK%. The operations processes contribute approximately 4.18% of the weighted average to the total ROK%. This shows that by examining only operations and maintenance processes that deal with the planning and support of generating the squadron's flight schedule, the maintenance processes play a larger role.

3. Numerator

A market comparable obtained from NetJets Inc. was used to express the benefits generated in the numerator for the ROK ratio into the common units of dollars. The revenue used to generate the common units in the numerator was fixed at $9,200,000 per year for the purposes of the case study. This is a conservative estimate for potential revenue generated from an organization that conducts flight planning and maintenance activities. For the "As-Is", "To-Be", and "Radical" models, the revenue generated for both operations and maintenance to execute the processes in this case study is $4,423.08 per hour. In reality, revenue would likely increase from the "As-Is", "To-Be", and "Radical" models as the processes are improved through BPR. However, this was not explored in this case study.

4. Denominator

The denominator values in the ROK ratios represent the personnel costs per hour to execute the operations and maintenance processes in the "As-Is", "To-Be", and "Radical" models. The cost per hour in the "As-Is" model is $129.07. This is represented by $33.85 per hour for operations processes and $95.22 per hour for maintenance processes.

The total hourly cost in the "To-Be" model is $109.05. This is a decrease of $20.02 per hour from the "As-Is" model. The $109.05 is broken down as $27.57 per hour for operations processes and $81.48 per hour for maintenance processes. The decrease in costs per hour is attained using BPR techniques to eliminate redundant or low value processes.

The total hourly cost in the "Radical" model is $69.98. This is a decrease of $39.07 per hour from the "To-Be" model. The $69.98 per hour cost is broken down as $11.20 per hour for operations processes and $58.79 per hour for maintenance processes. The costs savings were achieved using BPR techniques to redesign the "As-Is" processes based on inputs from the Israeli Air Forces whose "As-Is" processes are closely modeled after what the team envisioned for the "Radical" models.

5. ROK%

The total return on knowledge percentages increases from the “As-Is”, “To-Be” and “Radical” models. The “As-Is” model returns a total ROK of 3427%. After incrementally improving the “As-Is” model with logical changes, the “To-Be” model returns a ROK of 4056%. This increase of 629% represents the result of applying minimal BPR techniques to reduce redundant processes and implementing small increases of information technology into largely manual processes. The “Radical” model returns an ROK of 6320% which is an increase of 2264% from the “To-Be” model. This model represents a larger redesign of processes with large increases of information technology to facilitate executing the processes. The input for the “Radical” models in both the operations and maintenance processes was attained from current practices in the Israeli Air Force who utilize an ERP program for similar processes. The Israeli Air Forces “As-Is” models and processes were the vision for the US Navy’s “Radical” models represented in this case study.

By assuming the “Radical” models were implemented in a US Navy squadron similar to the one examined in the case study, the following results could be expected. For the operations and maintenance departments to execute all of the processes on a daily basis to generate an approved flight schedule ready for execution would take approximately 7.2 hours of effort by the various actors occurring either in tandem or sequentially. The theoretical revenue generated per hour by these processes is $4,423.08. This would generate approximately $31,846 of revenue per day in the generation of a daily flight schedule. Assuming a squadron produces this flight schedule five times a week and 50 weeks out of the year, annual revenue of approximately $7,961,500 could be expected. The 12 squadron estimate revenue would be approximately $95,538,000.

The personnel costs to execute the processes in the “Radical” models for the operations and maintenance department are $69.98 per hour. By executing the processes in the same 7.2 hours and following the same number of occurrences per year to generate the flight schedule, the personnel costs per year to generate an approved flight schedule are $125,962.50. This would yield net revenue of $7,835,537.50 per year to generate a daily flight schedule using the processes in the “Radical” models. The personnel costs over 12 squadrons would be approximately $1,511,550.

The information technology costs for the system have not been addressed thus far. The following data has been obtained from Mr. Gamliel "Jicko" Shitrit, Director of Engineering at Xvionics Corporation. The costs to implement the system in one Navy Squadron such as the squadron used in the case study, VFA-14 would include implementation, licensing, maintenance, integration and customization. The total cost in year for a one squadron implementation would be approximately $585,000. This is a conservative estimate based on the number of systems the XV-OMS program would have to integrate with. The integration costs are approximately $50,000 per system XV-OMS would have to operate with. The $585,000 reflects only one integration cost of $50,000. This is a conservative estimate of the potential systems XV-OMS would have to integrate with as the current US Navy "As-Is" model reflects limited essential IT systems in use at the squadron level to conduct flight planning and maintenance activities. The costs to implement XV-OMS over 12 squadrons would be approximately $5,668,000 assuming each squadron integrated XV-OMS with one system. This reflects roughly a 10% discount in costs over a single squadron implementation.

The potential ROI from implementing XV-OMS ERP into a Navy squadron would be the annual estimated revenue of $7,961,000 less the personnel costs of $125,962.50 less the year one implementation cost of $585,000 divided by the personnel costs and implementation costs equals an ROI of approximately 1019.8% for one Navy squadron. The ROI for a 12 squadron implementation using the same formula would be approximately 1230.7%. These ROI calculations are based on conservative estimates of revenue and cost data and neither captures all of the potential costs, nor do they factor in the depreciation of the year one implementation costs over the lifecycle of the system. With over a 1000% ROI on the implementation of the XV-OMS system, these estimates are orders of magnitude above the breakeven point and make the acquisition and implementation of this system a real option for the U.S. Navy.

B. CONCLUSION

1. Implications for the U.S. NAVY

Based on the results from this research and examination of the XV-OMS ERP program, the following options are available to the U.S. Navy. The first is always to maintain the status quo and do nothing. This will produce ROI results shown in the "As-

Is" models for operations and maintenance. These processes are largely manual, take longer to complete and generate less potential revenue.

The second option would be to pursue implementation of the XV-OMS system at one U.S. Navy F/A-18 squadron, measure the results using this methodology throughout the process and determine if a larger implementation at multiple squadrons is warranted. This would be a natural risk reducing strategy as the system is installed incrementally at one squadron and could be operated in tandem with existing systems or processes until squadron personnel were fully trained on the system.

The third option would be to pursue a full implementation across multiple squadrons at NAS Lemoore Ca to generate the largest potential ROI. This is the most costly and risky strategy in the event the implementation fails or does not meet the needs of the users at the squadron level. However, this option, if implemented enterprise wide utilizing the "Radical" model would generate the largest potential ROI to the U.S. Navy.

There are additional options available, but these represent three viable options from which additional strategies could be derived from. These and other options depend on the organizational support of the U.S. Naval Aviation community and DoD acquisition community and assume funding and approval from stakeholders.

2. KVA Final Thoughts

Some general assumptions were made upon completing the KVA spreadsheets for the "To-Be" and the "Radical" changes to the scheduling process. The U.S. Navy squadron is not a "for profit" organization and therefore its value stems from the knowledge base inside of the squadron. That knowledge is the proficiency of each member from the individual pilots, the Commanding Officer, all the way down to the individual mechanics who ready the aircraft in support of the scheduled missions. The more knowledge gained, the more valuable the unit. This could be read as Return on Investment in an organization that does not utilize fiscal profit to measure ROI but uses mission accomplishment instead. The more secondary tasks that are required of individuals the less able they are to gain proficiency in their core capabilities due to time constraints. There are a finite amount of hours in a day.

By increasing the % IT usage in the squadron, we were able to improve the Return on Knowledge. We ascertained that a reasonable assumption is that by increasing the % IT in the squadron will decrease the time required to complete the process leading to an increase in output. With the increase in IT, the squadron is able to produce more than one schedule during the constraint of time in a business day. Simply, if they were a business, they could produce more widgets at a greater rate than a rival company that utilized the "As-Is" process. Theoretically, we could produce more schedules with the increase in IT usage. However, the squadron only needs to produce one schedule per day. If one was at the wing level with a large ERP that produced a schedule for multiple subordinate units this would possibly play a factor in decreased cost and increased revenue.

Further, increasing the % IT will increase the Return on Knowledge due to IT being utilized to complete the mundane task of schedule writing. This allows the pilots whose primary role is to increase their combat proficiency, to concentrate on actual flying tasks as they would have more time available to do so since their requirement to sit at a desk and generate a schedule is now compressed. More time to fly equates to higher proficiency which equates to a higher knowledge base inside of the unit. All of this will yield a higher Return on Investment.

Lastly, increasing the IT usage would lead to a reduction in costs via a reduction in manpower required to produce the schedule. The most pronounced effect on manpower would occur in the implementation of the "Super Radical" but all of the models represent a reduction in the force requirement to produce a quality assured flight schedule.

C. POTENTIAL FOLLOW ON RESEARCH

- Apply this methodology to all of the squadron department processes e.g. Safety, Training, Administration, etc
- Examine the implementation of an ERP at the Wing organizational level to centralize the scheduling of flight operations of all squadrons under their operational control.
- Conduct a Real Options analysis from the results of this case study to determine potential feasibility of implementation.

- Examine the potential effects of revenue on organizational processes by implementing an ERP system.
- Examine the cost of IT in an organizations process to include the acquisition of, implementation of and the maintenance.
- Review the Greek Air Force implementation of an ERP system into their flight scheduling processes.
- Examine the risks to the Navy for incremental implementation vs. enterprise wide implementation.

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